DATA SYSTEMS TECHNICIAN
1 & C, VOLUME 2

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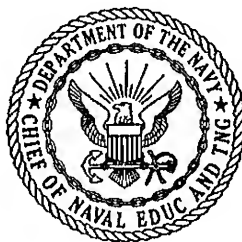
PREFACE

This rate training manual serves as an aid for enlisted personnel of the U.S. Navy and U.S. Naval Reserve, who are preparing for increased responsibility in the rates of Data Systems Technician First Class and Data Systems Technician Chief.

The manual was developed in two volumes. Volume 1, NAVEDTRA 10203, is classified CONFIDENTIAL. This is Volume 2, NAVEDTRA 10204-A and is unclassified. It covers the Total Maintenance Concept, Navy Command and Control System (NCCS), and Maintenance Programming and Troubleshooting.

A nonresident career course (NRCC) has been designed for use with this manual. It must be ordered separately from the manual. Ordering and enrollment information is available in List of Training Materials and Correspondence Courses, NAVEDTRA 10061 (Series). The assignments in the NRCC provide learning objectives and questions designed to lead the student through the content of the RTM.

This training manual and nonresident career course were prepared by the Naval Education and Training Program Development Center, Pensacola, Florida, for the Chief of Naval Education and Training. Special credit is given to the Combat Systems Technical Schools Command, Mare Island, Vallejo, Calif.; Fleet Combat Training Center, Pacific, San Diego, Calif.; Fleet Combat Training Center, Atlantic, Dam Neck, Virginia Beach, Va.; NAS Memphis, Millington, Tenn.; Naval Sea Systems Command, Washington, D.C.; Naval Electronic Systems Command Detachment, Patuxent River, Md.; and Atlantic Command Support Operation Facility, Norfolk, Va.

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THE UNITED STATES NAVY

GUARDIAN OF OUR COUNTRY

The United States Navy is responsible for maintaining control of the sea and is a ready force on watch at home and overseas, capable of strong action to preserve the peace or of instant offensive action to win in war.

It is upon the maintenance of this control that our country's glorious future depends; the United States Navy exists to make it so.

WE SERVE WITH HONOR

Tradition, valor, and victory are the Navy's heritage from the past. To these may be added dedication, discipline, and vigilance as the watchwords of the present and the future.

At home or on distant stations we serve with pride, confident in the respect of our country, our shipmates, and our families.

Our responsibilities sober us; our adversities strengthen us.

Service to God and Country is our special privilege. We serve with honor.

THE FUTURE OF THE NAVY

The Navy will always employ new weapons, new techniques, and greater power to protect and defend the United States on the sea, under the sea, and in the air.

Now and in the future, control of the sea gives the United States her greatest advantage for the maintenance of peace and for victory in war.

Mobility, surprise, dispersal, and offensive power are the keynotes of the new Navy. The roots of the Navy lie in a strong belief in the future, in continued dedication to our tasks, and in reflection on our heritage from the past.

Never have our opportunities and our responsibilities been greater.

CONTENTS

CHAPTER 1

THE TOTAL MAINTENANCE CONCEPT

All Data Systems Technicians must be familiar with and continually practice the total maintenance concept. Many factors contribute to the complexity of the DS duties and responsibilities. Equipment, while becoming more complex, is becoming more densely packaged. Systems are growing larger and encompassing more functions. Combat system testing has grown to include more of the ship's systems, and coordination of testing requires an even greater effort. As in the past, the majority of the skill training required by new personnel reporting to a command must be provided by the work group supervisor or shop supervisor.

As you advance, you'll find that you must acquire a broader knowledge on a wider variety of subjects in order to perform your duties in a professional manner. You must know more about testing of equipment and systems, environmental conditions of your systems, and quality assurance. The occupational standards for the DS rating list the areas of expertise required as a minimum. Many times you will have to acquire a working knowledge of support systems or a knowledge of areas not specifically covered by the occupational standards. This is part of the total maintenance concept. The total maintenance concept involves learning all of the knowledge factors and performing any task required to ensure the completion of all goals assigned to your work center or division.

The topics discussed in this chapter are Combat Systems Testing, the 2M Program, Quality Assurance, EMI, Outside Assistance, and Casualty Reporting.

COMBAT SYSTEM TESTING

Combat system testing should test the entire system under conditions which closely simulate operational conditions and allow monitoring of all data exchanged within the system. Periodic testing is required on any computer-controlled system to ensure that all components operate and interface properly.

Over the past two decades combat system testing has grown from a series of unrelated programmed tests on individual equipments (POFAs), through the Integrated Performance and Functional Appraisal (IPOFA) stage, to the Overall Combat System Operability Test (OCSOT). During this period improvements were made to various programs, but the first model of OCSOT was the greatest effort made to develop a completely integrated systems test. The earlier models of OCSOT left much to be desired in their ability to test the total system. With the advent of the Total Ship Test Program in 1973, a concerted effort has been made to develop an OCSOT to test all phases of the combat system.

TOTAL SHIP TEST PROGRAM

The major objective of the Total Ship Test Program (TSTP) for active fleet surface ships is to provide all combatant ships with an adequate and complete Planned Maintenance System (PMS) test package. This test package was developed as an integrated, nonredundant, total PMS test package structured around the scheduling and use of PMS system level testing at the highest level practicable. It allows the ship's material condition to be determined throughout the ship's entire life cycle.

Overall Combat System Operability Test (OCSOT)

The Overall Combat System Operability Test has been reconfigured and improved in conjunction with the TSTP. OCSOT checks the integrated combat system equipment, software, and interfaces (hardware to hardware, software to software, and hardware to software). It specifies parameters such as range, bearing, and elevation tolerances for all test phases as well as proper reaction times for systems and operators for both the simulated and controlled live target test phases. The results of OCSOT provide data for the total assessment of the material readiness of a ship's overall combat system. OCSOT also has value as a training vehicle for improving operational readiness of a unit.

The OCSOT being installed by NAVSEA representatives was developed under the TSTP. It is an improved, fully integrated version of the OCSOT used previously aboard tactical data systems (TDS) ships. The OCSOT is a PMS procedure that uses simulated targets, scheduled live targets, targets of opportunity, and/or a combination of these and the operational program. OCSOT can be conducted under almost any circumstances. The manning requirements set forth in OCSOT procedures require the combat systems to be manned at a modified general quarters (GQ) condition. This manning requirement can also be altered to fit the test phase(s) and/or test to be conducted.

OCSOT DESIGN CONCEPTS.—OCSOT was developed to provide a useful test vehicle to operate under a varying degree of conditions. It is divided into three phases: Phase I, Phase II, (Phase IIA, optional), and Phase III. The phases can be run individually or in combination with each other. This concept provides a flexibility that allows OCSOT to be used to fit the services available or the location of the ship.

OCSOT Phase I.—OCSOT Phase I tests the Missile Fire Control System (MFCS), Gun Fire Control System (GFCS), Antisubmarine Warfare (ASW) System, Electronic Warfare System (EWS), Tactical Data System (TDS) on integrated combatants, Chaff system (when applicable), and Intercept Control (IC) capability under the control of the Command and Control Complex using the normal quick response (QR) mode. The engagements occur sequentially and full-target simulation is used.

The following events are accomplished:

1. T0—Combat Air Patrol (CAP) deployment
2. T1—Subsurface engagement with ASROC backed up by Mk 46 torpedoes
3. T2—Surface engagement with GFCS
4. T3—Aircraft engagement with CAP under control of Link 4A
5. T4—Aircraft engagement with missiles and QR reflex capability
6. T5—Active and passive EW system checkout and Chaff exercise (if applicable)
7. T6—Subsurface engagement using LAMPS (if applicable)

Each of these tests exercises a subsystem of the combat system sequentially. Each step can be evaluated as it is performed or after the phase has been completed.

OCSOT Phase II.—OCSOT Phase II consists of a simultaneous multiple threat engagement using the same simulated targets used in Phase I. When directed by the Test Coordinator, appropriate stations are to simultaneously enter targets into the system as specified on the Operator's Function Checklist with the exception of the QR target. The SWC will enter the QR target after the fire control systems have been exercised.

This test simulates a realistic hostile environment in which the overall combat system is exercised in high density operations. Since the test closely parallels an actual combat situation, no step-by-step procedures are provided. An Operator's Function Checklist is provided to help run the test and to provide a means for monitoring proper test operation.

OCSOT Phase IIA.—Phase IIA is identical to Phase II except as follows:

1. Live targets are used for engagements.
2. Optional EW tests may be performed if "I" Band guidance radar equipped aircraft are available.

3. Long haul communication is established with any available source, and record and/or voice capability should be maintained throughout the running of this portion of the test.

4. If remote NTDS units are available, Link 11 and Link 14 communications should be established. The data links are to be initialized via hf and uhf voice communication. The remote NTDS units are to be entered into the net serially and ownship is to be net control ship (NCS) during the test.

5. Link 4A communication should be established if there is a properly equipped aircraft available. The data link is to be initialized via uhf voice communication.

6. Aircraft services used during this portion of the test are to be controlled by the Air Intercept Controller (AIC) using uhf voice communication, and a radio test of each ownship's hf and uhf radios should be performed prior to initiation of Phase IIA tests.

The Test Coordinator is responsible for scheduling all aircraft, surface, and subsurface services required for OCSOT Phase IIA.

OCSOT Phase III.—The OCSOT Phase III test provides actual rf lock-on and tracking of live targets of opportunity' to supplement the simulated target tests in Phase I and Phase II. Phase III is not required when Phase IIA is conducted. If ownship is at sea operating alone, Phase III may not be possible to accomplish.

In this phase of OCSOT, the test coordinator will select and designate targets of opportunity. Whenever possible, the size of aircraft, distance from ship, and so forth, should be considered to allow a realistic evaluation of the following operations:

1. Verification of Link 11 and Link 14 operation
2. Verification of BVP and AIMS operation
3. Tracking with search radars
4. Tracking with fire control radars
5. Verification of TDT operation
6. Verification of EW operation
7. Verification of electronic navigation equipment
8. Verification of RDF operation
9. Verification of TACAN operation

During OCSOT Phase III, a Tracking Data Comparison sheet is used to record data collected on target tracks. This sheet provides a means of comparing data obtained from each system for accuracy determination. The same air target is tracked by the MFCS, GFCS, and AN/SPS-48 radar. The range, bearing, and elevation obtained are compared with data from a reference director.

OCSOT TEST EVALUATION.—Results from running all OCSOT Phase I events can be checked for accuracy against acceptable reaction times, and azimuth, range, and elevation repeat-back tolerances specified for the tests. Automatic data extraction for all Phase I events is available for use in test evaluation aboard TDS equipped ships. Results from other phases of OCSOT are judged by whether the event performed operated satisfactorily within the guidelines set for the event. For example, if all Link 11 tracks sent were received in their proper position by a remote NTDS unit, the test of Link 11 would be satisfactory.

OCSOT FAULT ISOLATION.—A fault isolation guide is included. It consists of a tabular listing of selected combat system functions referenced to the appropriate test steps of Phase I with recommended fault isolation checks and tests. Fault isolation is keyed to localization and isolation of the problem source. Prior to initiating detailed fault isolation procedures when a fault occurs, the operational step should be repeated to verify that a fault actually exists and is not the result of an operator error. Should the fault still exist, ensure that the combat system is properly configured for the test event being performed. Are all switches set properly? Are you entering the correct function codes? It is amazing how switches on switchboards can wind up in the wrong position if care is not exercised. If the fault still exists, proceed with the detailed fault isolation procedures outlined.

Some of the tests which are used for further fault isolation are:

1. Combat System Operability Test (CSOT)
2. Daily System Operability Test (DSOT)
3. Combat System Alignment Test (CSAT)
4. Combat System Interface Test Tool (CSITT)

5. System Interface Test (SIT)
6. System Operability Test (SOT)
7. General Purpose Intercomputer POFA (GPIC)
8. NTDS POFA(s)
9. Computer Driven Diagnostics
10. Equipment Level (manual tests)

These tests isolate a problem down to a subsystem level, an equipment level, an equipment unit, or a component level. They can also be used for radar alignments tests (CSAT), checking the interface between the MFCS computer and the NTDS computer (CSITT or GPIC), and system operability tests (DSOT or CSOT).

OCSOT EFFECT ON PMS.—With the implementation of OCSOT under the TSTP, numerous PMS requirements have been satisfied and/or reduced in periodicity. These PMS requirements are not only in the NTDS area, but are in the GFCS, EW, IFF, and combat system areas as well. The OCSOT satisfies the main objective of the TSTP, to test at the highest level practicable and reduce redundant testing.

SCHEDULING COMBAT SYSTEM TESTS

The most time consuming facets of combat system testing are coordinating the activities of the various ratings involved aboard ship and procuring the services required for live target tracking from activities external to the ship. The combat system testing and coordinating responsibilities aboard ship are normally assigned to a commissioned officer or warrant officer designated as the System Test Officer (STO). Aboard some smaller ships, the System Test Officer duties may be assigned to the senior MCPO or SCPO in the weapons/operations department or combat systems department. As a DS1 or DSC, you will be required to assist the System Test Officer in scheduling various system tests.

Shipboard Test Coordination

Coordinating the running of system tests involves as many as a dozen ratings from DSs to STs and up to twice as many work centers. The most effective way to coordinate shipboard combat system testing is to organize a system test team consisting of the senior PO or CPO from each rating. The system test team should meet monthly to review system status and determine what testing will be done the next month. With as many as fifteen or twenty different subsystems (gun, missile, radar, sonar, and so forth), there is always a chance that one of the systems is down and testing cannot be performed in that area. If your gun system is down, the surface gun portion of Phase I can be omitted. Good coordination and planning in the preliminary stages of testing will help eliminate confusion and wasted time during the actual tests. The STO should always be kept informed of any changes in system status.

The equipment which makes up the shipboard tactical data system is the keystone of combat system testing. As a work center or group supervisor, you need to be aware of the status of all equipment under your cognizance. Your subordinate technicians should be made aware of the importance of keeping you informed of any change in the status of the equipment they maintain. In turn, it is your responsibility to keep the System Test Officer informed of any and all changes in the status of your equipment. This will ensure that the STO has current data. Test plans can be modified as dictated by system conditions.

Offship Services Coordination

Offship services (planes, helicopters, ships) are required for a number of combat system tests. Combat System Alignment Test (CSAT) requires the services of a plane or helicopter for checking radar alignment. OCSOT Phase IIA requires live targets for engagements. In addition, the configuration of the target aircraft will determine if the optional EW tests can be performed. The STO will normally follow TYCOM instructions and request the scheduling of various services to be used during combat system testing. Sometimes services can be arranged by phone in port. The normal procedure is a message requesting services for upcoming tests. If services are arranged by phone, a follow-up message should be sent to provide a reference and obtain a firm commitment for the service aircraft or ship.

2M PROGRAM

The increased equipment complexity, miniaturization, microminiaturization, and current high tempo of operational requirements have placed an increasing burden on maintenance personnel and facilities. These problems have been further aggravated by the varied manufacturing methods and techniques used by equipment manufacturers. Maintenance personnel have to be properly trained and certified to make high-quality, reliable repairs to a wide variety of state-of-the-art electronic printed circuit boards and modules. The Naval Sea System Command (NAVSEASYSCOM) has developed a training program under guidelines established by the Chief of Naval Operations (CNO), and at the direction of the Chief of Naval Material (NAVMAT). This program is the Miniature/Microminiature (2M) Electronic Repair Program. The 2M Program provides for the following:

1. Proper training in the art of miniature and microminiature repair.

2. Authorization to procure the tools and equipment to carry out the goals of the program.

3. Personnel and activity certification conducted by fleet and type commanders.

These provisions ensure the continuance of high-quality standards.

2M PROGRAM SCOPE

The 2M program objective is to provide the fleet with a miniature electronic repair capability at all maintenance levels, afloat and ashore. The 2M program also provides a microminiature repair capability on selected ships, Intermediate Maintenance Activities (IMAs), and shore facilities. At each respective activity, repairs shall be made to those components that are Source, Maintenance and Recoverability (SM&R) coded on the Allowance Parts List (APL) for that maintenance level. The 2M program is also intended to provide organization and intermediate level maintenance activities with the capability to repair, on an emergency basis only, components coded for discard or depot level maintenance.

2M Program Definitions

Before proceeding further with a discussion of the 2M program, some of the terms used in the program should be defined. This will answer any question you might have about what constitutes an item which is miniature repairable or microminiature repairable.

MICROELECTRONICS.—Microelectronics is the area of electronic technology associated with or applied to the production of electronic systems from extremely small electronic elements or parts. Microelectronics includes extremely small circuits having a high equivalent circuit-element density. These circuits are considered to be a single part composed of interconnected elements deposited on or within a single substrate which performs an electronic circuit function. Included are all types of integrated circuits (ICs) or large scale integrated (LSI) circuits mounted in flat packs, dual-in-line packages (DIPs), and other microelectronic packages. Normally, only external bent or broken connections on microelectronic packages can be repaired outside a laboratory. For additional information on microelectronics and micro-electronic construction details, refer to *Miniature/Microminiature (2M) Electronic Repair Program,* Volume III (Reference Data), NAVSEA TE000-AA-HBK-030-2M.

MINIATURE ELECTRONICS.—Miniature electronics, which is not a clearly defined area of technology, includes miniature electronic packages such as printed circuit boards (PCBs) and other assemblies which contain discrete components. "Mother" boards with plug-in PCBs and other assemblies are part of miniature electronics. PCBs and other assembly-mounted miniature electronics may include miniature motors, synchros, timers, optical or mechanical encoders, sensors, relays, and other miniature electronic/electrical devices.

MINIATURE ELECTRONIC REPAIR.—Miniature electronic repair includes all repairs to single-sided and double-sided PCBs and other miniature components. This includes: the removal and installation of DIPS and other micro-electronic packages; the repair of PCB laminate and printed wiring; and removal and application of conformal coating. These repairs can be

satisfactorily made under this program only with proper training, parts, and equipment approved for 2M use.

MICROMINIATURE ELECTRONIC REPAIR.—Microminiature electronic repair of miniature electronics includes all the more delicate repairs requiring the use of more sophisticated equipment. Microminiature repair includes all repairs described under miniature electronic repair and, also, all repairs to multilayer PCBs and small "daughter" boards (too complex and densely packaged for miniature electronic repair). Flexible PCBs, flexible printed circuit cables, and repair, removal, and installation of special connectors, eyelets, and terminals are also categorized as microminiature electronic repair. Repairs may include electroplating, microsoldering, the use of a stereo microscope, or the complete rebuilding of all or part of a PCB or other miniature electronic assembly. Authorized repairs to optical encoders and edge-lighted panels are included in microminiature repair.

2M REPAIR.—The NAVSEA 2M program identifies two basic skill levels in the repair of miniature electronic circuits, miniature electronic repair and microminiature repair. Any repair made to units identified in these categories is a 2M repair.

2M Repair Limitations.—Internal repair to microelectronic packages is not authorized under the 2M program. Similarly internal repairs to special components and miniature assemblies which may be critically sensitive to frequency, voltage, and temperature (such as miniature radio frequency balanced mixers), and require the use of special equipment and calibration, are not authorized under the 2M program. Normal 2M repair is limited to the levels and types of repair taught in the approved 2M training courses.

2M CERTIFICATION

The primary means of ensuring quality assurance of the 2M program is annual certification of personnel and repair sites. 2M trained inspectors from Mobile Technical Units (MOTUs) are designated by NAVSEA to annually inspect and recertify 2M sites and technicians. To

be certified, a site must have on board two, 2M technicians certified at the appropriate skill level for each 2M repair station installed.

2M Station Certification/Recertification Requirements

Each authorized 2M repair station must maintain current certification status. To maintain current certification status, a site must (a) have the proper equipment available in the proper condition and (b) meet facility requirements.

2M EQUIPAGE REQUIREMENTS.—Each authorized 2M repair station must have available the proper equipment in good working condition.

Miniature electronic repair stations shall be equipped with all items listed in Allowance Equipage List (AEL) No. 2-670034022 (Tools/Equipment-Miniature Electronic Repair). All tools listed should be kept at the repair station and not be used for other purposes.

Microminiature electronic repair stations shall be equipped with all items listed in AEL No. 2-670034035 (Tools/Equipment-Microminiature Electronic Repair).

It should be noted that since the skill levels acquired during training and initial certification were developed using the equipment listed in the AELs, substitutions of required items should be kept to a minimum. When a question arises as to whether another item may be substituted for a required item listed in the AELs, 2M inspectors may provide technical advice. Questions unresolved by the 2M inspectors are to be referred to NAVSEA 06C12.

2M FACILITY REQUIREMENTS.—Adequate facilities include consideration of lighting, ventilation, physical accommodations, security, and noise levels for each activity or work station. With the exception of requirements imposed by the Naval Environmental Health Center and other appropriate authorities for ship and shore work conditions, requirements will be tailored by each activity to provide a repair site which meets the following criteria:

1. The lighting requirement is to provide 100 footcandles, measured at the work surface, from a direct lighting source. Light-colored ceilings,

walls, and workbench tops will be used to complement the lighting provided.

2. Adequate ventilation is required because of the toxic fumes given off by solder, coating materials, grinding dust, and plating materials. Use of toxic and flammable substances, solvents, and especially coating compounds dictates the need for a ventilation system ducted to the outside to prevent contamination of normal closed ventilation systems. This is particularly important on board ship. Vented hoods, ducts, or laminar flow installations which exhaust outside must meet the minimum standards set by the Naval Environmental Health Center. An example of this is when you are using 1, 1, 1—Trichloroethane (methyl chloroform). No more than 350 parts per million (ppm) of solvent should be in the atmosphere during any given eight-hour period. Existing ventilation systems cannot meet this criteria.

3. Noise levels in the work area must be acceptable for exposure of personnel for normal work periods as approved for each activity involved (i.e., ship, IMA). Due to the tedious and tiring nature of this type of work, the noise levels will be as low as possible. Ear protectors may be used by 2M repair technicians if necessary.

4. Work stations will have a minimum work surface 60-inches wide and 30-inches deep. Standard Navy desks are excellent, but standard shipboard workbenches are acceptable. Chairs, with backs and without arms, should be comfortably padded and of the proper height to be compatible with work surfaces. The work surface should be white, heat resistant material (Formica or a similar type). The work station should have drawers or other tool storage facilities.

5. A 2M work station shall be capable of becoming a static-free work station as specified in NAVSEA OD 46363, *Requirements for the Electrostatic Discharge Protection of Electronic Components and Assemblies*. When equipped as a static-free work station, no work on energized circuits will be performed within three feet of the 2M work station.

6. No special power or equipment mounting is required. The repair equipment operates on 115 V ac, 60 Hz power. A 15-ampere circuit is sufficient and should have six individual power receptacles.

Technician Certification/Recertification Requirements

Technician certification and recertification involve the demonstration of knowledge, skills, and the ability to perform tasks to a satisfactory degree of proficiency. After the initial certification, technicians must be recertified once a year. Recertification should always be obtained prior to extended deployments if current certification will lapse during that deployment. The appropriate inspector(s) should be contacted far enough in advance of a deployment to allow for scheduling of recertification of your technicians.

INITIAL 2M CERTIFICATION.—Initial 2M certification is normally accomplished through successful completion of training specified in NAVSEAINST 4790.17 (Series). Upon completion of the specified training, the 2M qualified technician will be certified for a period of one year.

2M RECERTIFICATION.—The recertification process for 2M repair technician consists of an evaluation of capabilities by a 2M inspector. This includes practical demonstration of the repair technician's proficiency and evaluation of past repair work. Recertification is usually conducted at the technician's activity but may be accomplished at a MOTU. If required, on-the-job training may be provided by 2M inspectors to ensure technicians maintain current capability.

2M PERFORMANCE TESTS.—Performance tests for recertification of individual technicians require a demonstration of acceptable knowledge and skill levels through accomplishment of typical repair tasks. Minor training and practice may be included if the 2M inspector feels it is necessary for the technician to reach an acceptable level of proficiency. By observing the processes and finished work from the repair tasks, a qualified 2M inspector can accurately determine the technician's performance level. Performance tests are provided for both miniature and microminiature repair technicians.

2M Miniature Electronic Repair Technician.—A technician qualified to perform

miniature electronic repairs must show the ability to perform consistently reliable repairs on miniature circuits. The knowledge and skills that must be mastered and demonstrated include all of the following:

1. Installing and soldering components on printed circuit boards

2. Removing conformal coating and potting compounds

3. Desoldering and removing both miniature and microminiature components

4. Repairing damaged circuit boards

5. Hand soldering turret, bifurcated, and hook and tab terminals

6. Using solderable connector pins

7. Maintaining the repair station

8. Observing safety precautions as taught in the 2M miniature repair course

9. Making high reliability microminiature solder connections on single- and double-sided PCBs

10. Performing a valid analysis of the repair tasks required and the procedures necessary to accomplish a repair

2M Microminiature Electronic Repair Technician.—A technician qualified to conduct microminiature component repairs must demonstrate knowledge and skills superior to those required of the average miniature component repair technician in performing the same type of tasks. In addition, the microminiature repair technician must master repair tasks which are beyond the capability required of the miniature repair technician. Some of the areas of component construction that a microelectronics repair technician must understand include: microminiature size of components; hard to remove conformal coatings; susceptibility to damage; complexity of laminates; multilayer construction; high density packages for discrete components; and extent of damage to the component undergoing repair. In addition to the skills of the miniature electronics repair technician, the microminiature electronic repair technician must master and demonstrate the following skills:

1. Desoldering and removing components in microminiature circuits

2. Repairing microminiature and multilayer circuit board laminates and conductors

3. Consistently making high reliability, microelectronic solder connections

4. Splicing electrical wire

5. Repairing microminiature solderable connectors

6. Correctly disassembling, repairing, cleaning, and reassembling digital encoders

7. Repairing plastic edge-lighted panels and their conductors

8. Electroplating electronic circuit conductors, including edge connectors

9. Maintaining and repairing the microminiature repair station and its components

10. Demonstrating the ability to inspect microelectronic repairs and identifying defects in workmanship affecting reliability

ISSUANCE OF IDENTIFICATION CARDS.—Upon the successful completion of the applicable performance tests by the student/technician, the 2M inspector (i.e., MOTU, 2M School) will issue the appropriate ID card, record its issuance, and forward a completed NAVSEA 2M Program Certification/Recertification card to NAVSEA 06C12. These cards are provided to 2M inspectors by NAVSEASYSCOM (NAVSEA 06C12), Washington, DC 20362.

2M INSPECTOR RECERTIFICATION REQUIREMENTS.—Each 2M inspector will qualify for recertification annually by returning to Fleet Training Center (FTC), Norfolk, Va., or Advanced Electronics School Department, Service School Command (SSC), San Diego, Calif. A three-day evaluation/update will be conducted at these sites by a 2M instructor to discuss any changes to training course content, AELs, or techniques in the repair area. The school will then make a recertification recommendation to NAVSEA. Inspector recertification will then be provided by NAVSEA or its designated representative.

2M TRAINING

The 2M training courses are conducted at NAVSEA sponsored schools at the following locations: FTC, Norfolk, Va.; FTC, Charleston, S.C.; and the Advanced Electronics School at

SSC, San Diego, Calif. Two additional training sites have been proposed; Mayport, Fla., and Pearl Harbor, Hawaii. Training is also available at 12 Naval Air Maintenance Training Detachments located throughout the country. The 2M miniature electronic repair technician course is four weeks, and the microminiature electronic repair technician course adds an additional two weeks to that course.

2M SUPPLY SUPPORT

Initial outfitting for ships (excluding new construction) is provided by NAVSEA 06C1. Other ships, such as new construction, should obtain their initial equipment through NAVSEA 06C1, 2M Acquisition Engineering Agent, Naval Underseas Warfare Engineering Station (Code 2640), Keyport, Wash. Consumable items for 2M repair stations are obtained via MILSTRIP by the requesting activity.

Additional documents providing information on the 2M Program include the following:

- NAVSEAINST 4790.17 (Series), Miniature/Microminiature 2M Electronic Repair Program; responsibilities and procedures for

- NAVSEA TE000-AA-HBK-010/2M, Repair Handbook

- NAVSEA TE000-AA-HBK-020/2M, Workmanship Standards

- NAVSEA TE000-AA-HBK-030/2M, Reference Data

QUALITY ASSURANCE (QA)

As a DS1 or DSC, you will be responsible for ensuring that the work performed by your technicians is of the highest quality possible. The majority of the personnel in the DS rating take pride in the performance of their jobs and normally strive for excellence. However, every individual has an off-day. Your best 2M technician may have had the mid-watch the previous night. When an individual is tired and not 100 percent alert, oversights or mistakes are easy to make. As the work group or work center supervisor, one of your many responsibilities will be to ensure that all corrective action performed is accomplished correctly and meets prescribed standards. If a repair is performed improperly, it could endanger an expensive piece of equipment or at the least cause a piece of equipment to fail prematurely. A well organized quality assurance and inspection program in your work center will minimize the impact of a moment of carelessness or inattention. To make any program successful, you will have to obtain the cooperation and participation of all your shop personnel. After spending several hours troubleshooting a problem in a piece of equipment, nothing is more irritating for a technician than to find an improperly repaired component as the source of failure. This type of irritation can be totally eliminated with a successful quality assurance (QA) program. The primary purpose of a quality assurance program is to reduce or eliminate defects in any unit, module, or PCB repaired by your personnel.

CONCEPTS OF QUALITY ASSURANCE

The quality assurance concept is basically that of the prevention of the occurrence of defects. Quality assurance covers all events from the start of a maintenance action to its completion and is the responsibility of all maintenance personnel. The achievement of quality assurance depends on prevention, knowledge, and special skills. These factors are defined as follows:

1. Prevention relies on the principle that it is necessary to preclude maintenance failure. This principle extends to safety of personnel, maintenance of equipment, and virtually every aspect of the total maintenance effort. Prevention is concerned with regulating events rather than being regulated by them.

2. Knowledge is derived from factual information. It introduces data collection and analysis as a means of obtaining knowledge. It provides the "how to" and "why is it" required during any maintenance action.

3. Special skills, not normally possessed by average shop personnel, are required of a cadre of trained personnel for the supervision of a QA program.

OPERATION OF A QUALITY ASSURANCE PROGRAM

Initiating an effective, ongoing QA program is an all hands effort. It takes the cooperation of all shop personnel to make the program work. As the shop or work group supervisor, it will be your responsibility to overcome inertia and get the program rolling.

The key elements of an effective quality assurance program are as follows: a good personnel orientation program, a comprehensive personnel training program, use of the proper repair procedures, and uniform inspection procedures. When you have organized the shop or work center and have placed all these elements in practice, your quality assurance program will be underway. The elements are discussed in the following paragraphs.

Personnel Orientation

The best method to get the support of your personnel is to show them how an effective quality assurance program will benefit them personally. The elimination or reduction of premature failures in repaired units and the introduction of high reliability repairs will appreciably reduce their workload, saving them minor frustration and enhancing the shop or work group reputation. Any new program or change to an existing program will meet with opposition from some shop personnel. By showing your shop personnel the benefits of a quality assurance program, you greatly reduce opposition to change.

Personnel Training

A comprehensive personnel training program is the next step in an effective quality assurance program. Costly mistakes, made from either a lack of knowledge or improper training, can be almost entirely eliminated with a good training program at all levels of shop or work group organization. Use of your more experienced technicians to pass along "lessons learned" will further enhance your training program.

Many of the DSs who arrive at various sites, fresh out of A or C school, possess a minimal knowledge of soldering techniques and the proper use of handtools. These new personnel will require extensive on-the-job training to safely perform basic maintenance tasks. You may even have some older hands who still don't have the skills they need. The training program is your tool to bring everyone up to a proper level of proficiency.

HANDTOOLS AND SPECIAL PURPOSE TOOLS.—Training your shop personnel in the proper use of basic handtools and special purpose tools can be accomplished by a combination of on-the-job training, correspondence courses, and formal training. A good text on basic handtools for inexperienced personnel is *Tools and Their Uses*, NAVEDTRA 10085 (Series). This text provides the individual with information about handtools and their proper use. Additional information on common handtools used in maintenance of electronic equipment may be found in Section Three of *EIMB, General Maintenance*, NAVSEA 0967-LP-000-0160. Special purpose tools such as wire wrap and unwrap tools, pin insertion and removal tools, and desoldering tools are not covered in this book. Information on special purpose tools may be found in a number of NAVSEA technical manuals for equipment installed at your site or aboard your ship. Information on the use and specifications of various special tools may be obtained from the tool manufacturers.

SOLDERING TECHNIQUES.—Knowledge and skill in proper soldering techniques can only be acquired through training and practice. An excellent school on basic soldering techniques is held by various MOTUs. Here facilities and trained personnel are available to provide the tyro technician with the knowledge, practice, and equipment required to develop soldering skills. Messages announcing the availability of the basic soldering courses are sent out on a regular basis by the MOTUs. Quotas for personnel desiring to attend should be requested by message.

Personnel who display special talent for soldering are rare. The manual dexterity and coordination required for repair of miniature and microminiature circuits are not possessed by many individuals. Occasionally, an individual attending the MOTU soldering classes will display a special talent for producing high reliability solder connections. The instructors at MOTU will usually recommend this individual for the 2M

repair school. This is one of the better ways for you to determine which of your personnel should attend the 2M repair course.

Repair Procedures

Repair procedures may be defined as all of the actions required to return an equipment to its proper operating condition after a defect has been discovered and isolated to a subunit or component. Repair procedures discussed include: parts handling procedures, disassembly practices, component removal/replacement, soldering procedures, and assembly practices. Strictly adhering to the proper repair procedures will almost entirely eliminate premature failures.

PARTS HANDLING.—Parts handling, an important phase of repair, includes the handling of failed units, repair parts, and repaired units. Improper handling can damage repaired parts, repaired units, or further damage a failed unit. Improper handling also increases the cost and time involved in returning a unit or module to a ready for issue (RFI) condition. Many components of today's complex electronic digital equipment require special handling procedures for a number of reasons. Ensure that your technicians always handle digital components, subunits, or PCBs in accordance with prescribed procedures.

Of special concern are electrostatic sensitive devices (ESDs). ESDs may be destroyed simply by picking them up without having your wrist grounded. The slight static charge which builds up in a person's body under normal conditions is enough to destroy a component classified as an ESD. Section 4 of *Miniature/Microminiature (2M) Electronic Repair Program*, Volume III, Reference Data, NAVSEA TE000-AA-HBK-030/2M, provides specific details about the common sources and the detrimental effects of electrostatic discharge and the controls available to reduce the danger. The shop supervisor and repair technicians should be thoroughly familiar with the contents of this section.

All defective or repaired modules, units, or PCBs should be stored in such a way to prevent damage from either a mechanical or electrical source. Any shop which repairs and overhauls any digital electronic components should have adequate space for the proper storage of these units.

It is the responsibility of the shop superv and subordinate work group supervisors to er that the proper procedures are used in hanc all repairable units.

DISASSEMBLY PRACTICES.—Disas bly of a unit, subunit, or module should r be attempted by an inexperienced person personnel should receive training in the pr method of disassembly of the particular units which they will be working. Detailed asse breakdown drawings are available in the tech manual for a particular equipment in Secti (titled either Repair or Corrective Maintena The assembly breakdown drawings particularly helpful in identifying the compo and in the proper method of assembly disassembly of electromechanical units.

When complex electromechanical unit disassembled, care should be taken in storin separating mechanical parts such as screws, washers, spacers, and clips. A multicon mented plastic box with a cover is especially for storing these small parts until a uni undergone repairs and can be comp reassembled.

Careful disassembly of a unit and a inspection of all mechanical parts is the fir in repairing any item. At this time any parts are noticeably worn or damaged shou replaced or ordered if not carried in supply the unit can be cleaned and visually inspec this time for any other signs of mech damage to printed circuit conducto components.

COMPONENT REMOVAL/REPL MENT.—The removal and replaceme defective components is the most critical i any repair. Excessive heat, overuse of sol a slip of a pair of pliers can negate all step: to safeguard the unit undergoing repair.

Miniature/Microminiature (2M) Ele Repair Program, Volume II; Workm Standards, NAVSEA TE000-AA-HBK-0 should be your primary reference for re miniature and microminiature electronic ui the work group or shop supervisor, you responsible for checking the quality of made to 2M components. All repairs shou or exceed the standards of Volu

Workmanship Standards. You must be completely familiar with the contents of this handbook to perform your role effectively. Furthermore, you must ensure that all of the technicians under your direction follow the guidelines set forth in this publication.

SOLDERING PROCEDURES.—If the correct procedures for soldering are not used, expensive semiconductor devices can be damaged or destroyed. The application of the proper amount of heat to make a reliable solder connection is always critical. Too much heat can damage the component or board; too little heat can result in a cold solder joint. Too much solder or sloppy soldering techniques can result in shorting printed-wiring runs together. Too little solder can result in a poor electrical and mechanical connection.

Sections 2, 3, and 4 of the Workmanship Standards Handbook depict ideal, acceptable, and unacceptable methods of attaching and soldering various components to electronic PCBs and assemblies. These standards provide the quality assurance inspector with the guidelines for accepting or rejecting repairs made to various assemblies.

ASSEMBLY PRACTICES.—After all defective components have been removed, replaced, and resoldered to a PCB or assembly, the final step is a thorough cleaning, visual inspection, and assembling of the repaired unit. Parts previously separated and stored during the disassembly of the unit should now be used to assemble the repaired unit. Here again, the assembly breakdown drawings from chapter 6 of the technical manuals should be used by the technician. Often a considerable period of time elapses from disassembly to assembly. To ensure that a unit is correctly assembled, the technician should always use the assembly drawings.

All mechanical parts removed during the disassembly of electromechanical units should be replaced during assembly of the repaired units. All lock washers, spacers, screws, nuts, and washers should be installed in their proper places. They provide for the mechanical integrity of the unit; it is not up to the technician to omit them because it is faster to repair the unit, or because of a personal opinion that all of the screws are not needed.

Inspection Procedures

As the QA inspector of your work group or shop, you are responsible for ensuring that all repaired units are ready-for-issue (RFI). This doesn't mean that you have to inspect each item repaired in your shop personally; you should have two reliable, well-trained technicians to assist you in QA inspection. QA inspectors should not sign off or inspect any item(s) that they have worked on. This ensures the integrity of your QA program. QA inspections fall into two categories: visual and dynamic.

VISUAL INSPECTION.—Every unit that has been repaired should have a good visual inspection performed on it. Ideally, the unit being repaired should be inspected after disassembly for any obvious mechanical damage to the PCB, components, or any of the mechanical components of the unit. It should also be inspected after a component has been removed, replaced, and resoldered onto the PCB or assembly. Mechanical connections, amount of solder used for the connections, position of the replaced component, bend radius of leads, and cleanliness of the solder connections should all be checked. The entire unit should again be checked after the installation of any mechanical hardware or components. This sounds like a lot of inspections; but remember, if anything is wrong it is easier to correct a problem at an early stage of the repair process than later when the unit has been recovered with a conformal coating. A mechanical or electrical defect could be screened by the conformal coating that might otherwise be obvious in an earlier stage of the repair process.

The decision to pass or reject any repaired units should be based on experience, common sense, and the examples shown in the workmanship standards volume of the 2M handbook. All inspectors should be thoroughly familiar with this handbook.

DYNAMIC TESTING.—The final "acid" test of a repaired unit is the dynamic test. The dynamic test checks to see if the unit works under typical operating conditions. Dynamic tests are usually performed on card testers. Card testers do an admirable job and will give a go or no-go indication in most cases. The ultimate test is to

place the repaired unit into the equipment from which it was removed and check to see if the equipment operates properly. If it does, your repaired unit is RFI.

STORAGE OF RFI SPARES.—The unit has now been repaired and tested. What next? After all of the care, inspection, testing, and time involved in bringing a module back to an RFI condition, you don't just toss it in a drawer someplace. Assuring proper storage is as important a part of a QA program as assuring quality in any step of the repair process.

All spare parts should be stored properly to protect them from dirt, moisture, and electrical and mechanical abuse. Adequate storage bins should be located in your shop facilities to store and protect RFI spares. The best protection is to keep the manufacturer's shipping containers and replace the repaired units in these containers after repairs and tests have been completed. If adequate storage is not available in your shop or work area, all repaired units should be replaced in their original containers and arrangements made with the supply department for their proper storage.

At this point it should be mentioned that supply personnel sometimes need a little education on the proper care and handling of electronic repair parts. As shop supervisor or work group supervisor, this is best approached at your level. A little coordination with the SK1 or SKC should resolve any storage problems you may encounter. Never accept RFI spares from the supply department if they are not in the manufacturer's shipping containers. They could be damaged, and the damage might not be obvious until after the unit is inserted into a piece of equipment and the smoke pours out. This has happened many times and is not very humorous for a technician who has worked all night to isolate a problem. It only causes more problems.

REFERENCE & DIRECTIVES

The following references provide more information on quality assurance, 2M standards, and high reliability soldering. They are helpful in establishing a quality assurance program and training QA inspectors.

● MIL-STD-1130, *Military Standards, Connections, Electrical, Solderless Wrapped*. This standard establishes the requirements to produce mechanically and electrically stable, solderless wrapped, electrical connections made with single, solid, round wire and appropriately designed wrapposts.

● NASA SP-5002, *Soldering Electrical Connections*. This handbook covers hand soldering, automatic machine soldering, termination of shields by soldering, and lacing of cable trunks. It depicts acceptable and unacceptable workmanship.

● NHB 5300.4(3A), *Requirements for Soldered Electrical Connections*. This handbook describes hand and machine soldering requirements for reliable electrical and electronic connections.

● NAVSEA TE000-AA-HBK-010/2M, *Miniature/Microminiature (2M) Electronic Repair Program*, Volume I, Repair Handbook. This handbook establishes uniform procedures and techniques for repairing high-reliability electronic assemblies to ensure the continuance of the original quality and reliability of the electronic component. At the same time, this handbook provides a basis for developing the skills of new personnel and controlling the end results of their repair actions.

● NAVSEA TE000-AA-HBK-020/2M, *Miniature/Microminiature (2M) Electronic Repair Program*, Volume II, Workmanship Standards. This handbook provides information and depicts standards for the following topics: Electronic Assembly and Soldering, Hand Soldering of Electronic Components to Printed-wiring Board Holes, Soldering to Terminals, Installation of Terminals, and Soldering Flat Packs.

● NAVSEA TE000-AA-HBK-030/2M, *Miniature/Microminiature (2M) Electronic Repair Program*, Volume III, Reference Data. The purpose of this handbook is to provide Navy technicians with sufficient background

information and reference material to assist them when performing maintenance on electronic equipment which contain microelectronic circuitry.

● COMNAVSURFLANTINST 9090.1, COMNAVSURFLANT Quality Assurance Manual; promulgation of. This instruction defines the purpose of QA, the steps required in ensuring that QA standards are met, and provides an insight into QA programs.

EMI

EMI (electromagnetic interference) is an electromagnetic or electrostatic disturbance that causes electronic equipment to malfunction or to produce undesirable responses or conditions which do not meet the requirements of interference tests. The increase in the number of different types of electronic and electrical equipment since the beginning of World War II, has brought about a problem which was given little consideration in previous years—EMI. The number of electronic and electrical devices installed aboard ship and used ashore have increased dramatically. Naval ships and aircraft now contain a large number of complex, sensitive devices which are not always compatible with one another.

As a DS1 or DSC, you must be more aware of the problems caused by EMI and the solutions that are required to resolve these problems. No magic is involved in reducing or eliminating EMI. Everyday common sense approaches to maintaining equipment will resolve many problems caused by EMI.

SOURCES OF EMI

There are three sources of electromagnetic interference:

1. Natural
2. Inherent
3. Man-made

Natural interference is caused by natural events, such as snow storms, electrical storms, rain particles, and solar radiation. This type of interference is commonly called static or atmospheric noise. It can cause problems with rf data links between shore, ship, and air, but few problems with modern digital data equipment.

Inherent interference is noise within a piece of electronic equipment and is caused by thermal agitation of electrons flowing through circuit resistance. This noise is usually noticed as the background noise heard in a radio receiver when it is tuned to a frequency in-between stations. It is normally of little consequence to the DS unless the receiver used for the Link 11 has a high inherent noise level.

Man-made EMI is produced by a number of different classes of electrical and electronic equipment. They include, but are not limited to: transmitters; welders; power lines; motors and generators; lighting; engines and igniters; and electrical controllers. A number of these devices can cause severe EMI which can degrade the operation of shipboard or shore-based data processing equipment.

The discussion of EMI will be directed to the recognition and elimination of man-made EMI which the DS will encounter ashore or afloat.

Types of EMI

EMI can be classified by its spectrum distribution. EMI can be either broadband or narrowband interference. These terms refer to the frequency spectrum the interference covers.

Narrowband EMI consists of a single frequency or a narrowband of interference frequencies. Narrowband EMI usually has a minor effect on communications or electronic equipment. It can be tuned out or filtered out.

Broadband EMI is not a discrete frequency. It occupies a relatively large part of the electromagnetic spectrum. This type of EMI is usually caused by arcing or corona and causes the majority of EMI problems in digital data equipment. It will be especially noticeable when receiving data on Link 11. It is caused by the worn or improperly installed brushes of motors or generators, defective fluorescent lights, arcing of contacts in electrical controllers or stepping switches, ignition systems of motor vehicles, igniters for jet engines, and defective power lines or power transformers.

It should be mentioned that improperly bonded lifelines, rigging, jackstays, ladders, and stanchions produce a significant amount of EMI in a shipboard environment. They act as nonlinear mixing devices and antennas. They receive a number of different transmitted frequencies, mix them, and reradiate them over a broad spectrum.

CONTROL OF EMI

EMI can be controlled or eliminated if some simple procedures are followed and good installation practices are adhered to. Discussion of EMI control and reduction will be divided into two categories, shipboard and shore-based installations. Many of the problems and procedures for reduction are the same for both installations.

Shipboard EMI Control

Shipboard EMI control is greatly simplified for the typical digital data installation. Because of the ship's steel hull and construction, a great deal of shielding and isolation are provided the typical shipboard computer room or digital equipment space. This blocks out the majority of broadband interference generated both internally and externally. There are five major factors to be considered in a shipboard computer and digital equipment installation. They are:

1. Equipment location
2. Equipment shielding
3. System and equipment grounds
4. Interconnection cabling
5. Source of power

EQUIPMENT LOCATION.—Computers and digital equipment should be located in spaces which are free of sources of EMI. They should not be located in spaces which contain radars, radio transmitters, generators, or other rotating machinery. Simple attention to the location of digital equipment can reduce or eliminate many sources of EMI.

EQUIPMENT SHIELDING.—Digital computers or equipment should never be operated with drawers extended, cover plates removed, or doors open. Modern equipment contains EMI reducing gaskets and shields which enclose the equipment. Defeating these measures by operating equipment in this state can lead to serious problems. Always reinstall cover plates with all the fasteners in place. If a cover plate or shield has to be removed in the course of corrective maintenance, ensure that the EMI reducing contacts or wire gaskets on the equipment opening are in good condition before the cover or shield is replaced. If the contacts or gaskets are bad, replace them.

SYSTEM AND EQUIPMENT GROUNDS.— System and equipment grounds are extremely important in digital equipment installations. All cabinets should be grounded together on a common system ground bus. Normally a main system ground bus of about 70,000 circular mills (1.5 inches in diameter) or more is run through all spaces. Each equipment cabinet is connected to the system ground by a heavy ground cable. The system ground is securely attached to the hull of the ship and provides a good ground reference for the system. In addition, all equipment cabinets have ground straps bypassing the shock mounts attached to the metal decks or mounting racks. Paint on ground straps or on the metal decks where the ground straps are mechanically attached will result in a poor electrical connection. All terminal lugs or ground straps used to bond the equipment to the hull or the system ground should be bright, clean, and free of any foreign material. This is also true of grounding studs and the system ground cable. This ensures a good electrical connection. The grounded cabinets provide a shield at ground potential. This keeps in any signal which might cause a problem somewhere else in the system. It also keeps out stray interference which might cause a problem in a particular piece of equipment.

INTERCONNECTING CABLES.—All interconnecting cables used in a shipboard digital data system should be shielded cables. They should be assembled correctly according to installation drawings. The shield and connector shell should be electrically connected and properly secured at either end. Interconnecting cables may have to be routed through spaces where a potential for EMI exists (radar rooms, MG rooms, and the like). The cables should never be run in the same

cableways as cables carrying rf signals or high power pulse cables. The shielding protects the data cables from EMI to a great extent. This is only true if the cable is properly assembled and carefully routed to avoid strong EMI fields.

POWER SOURCE.—Power lines for digital equipment can provide a transmission path for EMI from machinery spaces. The majority of input power passes through noise elimination filters as it enters digital equipment. Failure of power line filters (actually bandpass/band reject filters) is rare but happens on occasions. Unusual random problems in digital equipment can sometimes be traced to defective line filters. Unusually large transient voltages on power lines may also cause EMI. The easiest way to check this type of problem is with an oscilloscope, an isolation capacitor, and a 10:1 probe. The probe and capacitor are connected in series with the main power deenergized. Power is applied and the scope is checked to determine if excessive noise or "hash" is riding on the input voltage.

CAUTION: Always observe all safety precautions while checking equipment input power.

Shore-based EMI Control

Control of EMI at a shore-based installation requires the consideration of the same factors as a shipboard system with two additions:

1. Site location

2. Soil quality

These two factors will require extra consideration because additional sources of EMI may be encountered.

SITE LOCATION.—Shore-based digital data equipment sites are sometimes built where the need dictates or where a convenient building is available. They are not always ideal sites. A site built near a large industrial complex such as a Shipyard Repair Facility (SRF) or a Naval Air Rework Facility (NARF), may be subjected to severe EMI. The SRF and NARF have one thing in common—both use many large rotating machines. These machines produce a lot of EMI.

They also can cause power line fluctuations if the power source of the shore site and the SRF or NARF are the same. In addition to EMI from machines, a large amount of EMI is generated by the welding which takes place in the nearby facility.

Special consideration should be given to the location of sensitive digital equipment at sites near a high noise industrial facility. In extreme cases, shielding may be needed around an especially sensitive piece of equipment to ensure its proper operation.

Additional line filters and regulators for power lines may also be required to reduce EMI and provide line power within the limits prescribed by equipment manufacturers.

SOIL QUALITY.—What does soil quality have to do with EMI? At a shore installation, a system ground bus is usually attached to a grounding rod driven into the soil. If the soil is dry, sandy, rocky soil such as that found in the southwestern United States and some places overseas, you will have a poor ground. Soil that is not ordinarily a good conductor must be chemically treated to increase its conductivity. It is possible to have a poor ground which actually acts like an antenna. The ground cable can, under these conditions, provide an EMI potential in excess of five volts between it and power ground. A suspected system ground can be checked with an oscilloscope and a 1:1 probe. Using power line ground as a reference, connect the tip of the probe to the system ground and the shield of the probe to power ground. An excessive amount of noise displayed on the oscilloscope may indicate a system ground problem. Refer to *Electromagnetic Compatibility*, NAVELEX 0967-LP-624-6010, for more information.

DIRECTIVES

Many directives which provide guidelines to follow for avoiding or reducing the effects of EMI are available. They are listed and described briefly in the following paragraphs. Reference to these documents will provide a wealth of information for the shipboard or shore-based DS.

Electromagnetic Interference Reduction

The EIMB handbook entitled *Electromagnetic Interference Reduction*, NAVSHIPS 0967-LP-000-0150, contains a wide range of information on EMI. Subjects covered are general sources of EMI, types of EMI, methods of coupling EMI, interference from electrical devices, communications equipment interference, hull-generated intermodulation interference, radar systems interference, and EMI reduction methods. The topics of shipboard EMI tests and operating practices for EMI reduction are also covered in this handbook.

Electromagnetic Compatibility

The Naval Shore Electronics Criteria handbook, *Electromagnetic Compatibility*, NAVELEX 0967-LP-624-6010 provides information on the reduction of EMI at shore-based facilities. The contents include system considerations; specifications, standards, and documents; utilization of the frequency spectrum; fundamentals of EMC/RADHAZ; evaluation techniques and measurements; and basic installation considerations. All facets of grounding, shielding, and equipment bonding are contained in this highly informative handbook.

The Electronics Material Officer's Guide to Shipboard Electromagnetic Interference Control

The Electronics Material Officer's Guide to Shipboard Electromagnetic Interference Control, N00123-75-C-0566, is a reference guide developed under the Shipboard Electromagnetic Compatibility Improvement Program (SEMCIP). It was designed to provide appropriate electromagnetic compatibility (EMC) information, based on SEMCIP "lessons learned" to EMOs afloat. It contains information similar to the previously described handbooks and sample problems. Inspection checklists and EMI troubleshooting charts are also contained in this publication.

MIL-STD-1310 (Series)

MIL-STD-1310 (Series) entitled *Shipboard Bonding, Grounding, and Other Techniques for*

Electromagnetic Compatibility Safety is a military standard for the proper construction of bonding straps, and grounding cables. It is the reference for all shipboard EMC installations. It contains drawings which depict the proper shape and lists materials required to construct bonding straps and grounding leads for shipboard electrical/electronics installation.

OUTSIDE ASSISTANCE

No matter how proficient a maintenance shop becomes, there will always be a time when outside assistance is required. This assistance may be either in the form of technical assistance from a MOTU, NAVSEA, and/or field engineer or technical documentation from NAVSEA, NAVELEX, or a commercial vendor. In the following paragraphs, the various sources of technical assistance available to the DS are discussed.

MOBILE TECHNICAL UNITS

The mission of the Mobile Technical Units (MOTUs), is to improve fleet electronics and weapons readiness by providing a cadre of versatile, highly skilled technical personnel under fleet control. Each MOTU is staffed with a group of highly qualified senior Navy and civilian technicians who provide technical services and on-the-job training (OJT) to units of the Navy. MOTUs are located as follows:

ATLANTIC FLEET

MOTU TWO	Norfolk, Va.
MOTU FOUR	Groton, Conn.
MOTU FOUR DET	Newport, R.I.
MOTU SIX	Naples, Italy
MOTU TEN	Charleston, S.C.
MOTU TWELVE	Mayport, Fla.
MOTU FOURTEEN	Kings Bay, Ga.

PACIFIC FLEET

MOTU ONE	Pearl Harbor, Hawaii
MOTU FIVE	San Diego, Calif.
MOTU NINE	Treasure Island, Calif.
MOTU SEVEN	Yokosuka, Japan
MOTU THIRTEEN	Subic Bay, R.P.I.

MOTUs provide the following services:

1. Technical assistance in the repair and installation of electronics and ordnance equipment, where such work is beyond the capabilities of forces afloat

2. On-the-job training (OJT) to fleet personnel in electronics and ordnance equipment maintenance

3. Informal short courses of instruction on the maintenance of selected equipment conducted either on board ship or at a local MOTU

4. Electronic and weapon system grooms, checks, reviews, or inspections for surface and submarine units

5. Other assistance in the field of electronics and weapon systems not specifically listed above, where such assistance is within the capability of the MOTU and compatible with their assigned mission

Request for technical assistance should be made only after all efforts by the ship's force have failed to correct the problem, and assistance from ships in company is unavailable or unsuccessful. Requests are to be made in time to permit work completion during normal working hours. This does not preclude utilization of overtime hours when operational commitments clearly call for it. A CASREP or message request for technical assistance is required in such cases. MOTUs will give first priority to CASREPs and situations which affect primary mission readiness.

When services are provided, it is mandatory that the technicians regularly assigned to the equipment be present and available when MOTU personnel are on board. Ship's technicians are to perform the work required, advised and assisted by MOTU personnel. The ship will provide calibrated test equipment in working condition, technical manuals, repair parts, maintenance requirement cards (MRCs), and adequate working facilities so that MOTU personnel may carry out their assignment promptly and efficiently.

Navy technicians provided by MOTU are assigned for the purpose of providing technical assistance and training, and will not be used as augmentation of ship's force for other purposes. Messing, berthing, and transportation are to be furnished where practicable, in keeping with the technician's rate. Refer to COMNAVSURF-LANTINST 9400.1 (Series), or COMNAVLOG-PACINST 9670.1 (Series), for further information.

NAVAL SEA SYSTEMS COMMAND DETACHMENTS

The Naval Sea Systems Command Detachments (NAVSEASYSCOMDETS) were created to deal with the increasing problems associated with shipboard maintenance. They are not maintenance activities, as such, but rather are an engineering management arm of the systems command. A detachment (DET) is organized to resolve maintenance problems by taking or recommending remedial action. The DET is concerned with maintenance in its fullest sense—design, installation, training, logistics, and technical information. The NAVSEASYSCOM-DETs are organized into the following divisions:

1. ASW
2. Radar and tactical data systems
3. Engineering and logistics support
4. Combatant craft engineering

Each division is subdivided into branches with project engineers and technicians assigned to exercise engineering maintenance management over each piece of equipment assigned.

The routine duties of a NAVSEASYS-COMDET include: investigation of maintenance deficiencies and trouble reports; engineering analyses and corrective recommendations; preparation of maintenance tips and procedures; development of field changes; reliability and maintainability analyses; training and manpower studies; and revision of technical manuals, maintenance standards books, and other documents. Additionally, information gained from shipboard experience is furnished to the systems command for continued improvements in new designs.

There are NAVSEASYSCOM facilities, activities, centers, and stations located throughout CONUS. They are not always called NAVSEA-SYSCOMDETs, but they are a source of assistance for the DS.

NAVSEA facilities are at the following locations:

1. Naval Sea Combat Systems Engineering Station

    (NAVSEACOMSYSENGSTA)—Norfolk, Va

2. Naval Sea Support Center Detachment

    NAVSEACENLANT DET— Charleston, S.C.

    — Groton, Conn.

    — Mayport, Fla.

    — Portsmouth, Va.

    NAVSEACENPAC DET — Pearl Harbor, Hawaii

    — San Diego, Calif.

    — Vallejo, Calif.

NAVSEA Technical Representative (NSTR)

In addition to the NAVSEACEN DETs and the NAVSEACOMSYSENGSTA, the NAVSEA Technical Representative, St. Paul, Minn. provides software distribution for Combat Direction Systems (CDSs). Software and documentation available from NSTR and the procedures for obtaining them are listed in the *Combat Direction Systems (CDS) Test Software User Documentation Index*, NAVSEA 0967-LP-011-017X. The documentation index is published on a regular basis by NSTR.

NAVAL ELECTRONICS SYSTEM COMMAND

The Naval Electronics System Command (NAVELEXSYSCOM) provides electronics material support for systems and equipment for which they are responsible. The equipment supported by NAVELEX is located both at shore sites and aboard ship. Shipboard electronic systems and equipment are supported through the Fleet Liaison Program. Shore-based electronic systems and equipment are supported by NAVELEX field activities. Some of the typical functions of NAVELEX field activities are as follows:

1. Represent COMNAVELEXSYSCOM on all electronic matters, ship and shore, concerning equipment and systems under the cognizance of NAVELEXSYSCOM

2. Provide maintenance engineering support for shore and shipboard equipment and systems under the cognizance of NAVELEXSYSCOM

3. Prepare Base Electronic Systems Engineering Plans

4. Perform engineering surveys for site selection

5. Prepare specifications

6. Prepare cost estimates

7. Perform design and installation engineering

8. Act as the technical advisor on matters pertaining to electronic material support

9. Exercise technical direction and supervision of electronics installation work performed by other than in-house personnel (contractors, etc.); perform check-out and technical acceptance of the installation when complete, and execute formal turnover of completed installation to the operating activity

10. Conduct inspections of electronic installations, and report status of material and logistic support

11. Perform electronics installation and certifications, and execute formal turnover to the operating activity

12. Conduct TEMPEST inspections and instrumented surveys, HERO surveys, and other EMR hazard and electromagnetic compatibility surveys as appropriate, and recommend corrective procedures

13. Establish and maintain liaison with activities of the Naval Facilities Engineering Command where joint effort is required in the planning and execution of shore electronic facilities projects to ensure that integrated electronics and facilities are provided which are adequate to the needs of the users

14. Render assistance, on request, in the maintenance and repair of electronic equipment beyond the capabilities of station personnel, but not in lieu of organizational maintenance. This assistance is supplementary to that normally provided through type commander service forces, and MOTUs for forces afloat

15. Establish liaison with other government agencies for electronic material support matters

16. Administer funding and manage the cryptographic repair program, the general purpose test equipment calibration and repair program, the electronic equipment and component repair

program, and the RADIAC calibration and repair program

NAVELEXSYSCOM Fleet Liaison Program

The goal of the Fleet Liaison Program is to ensure maximum support to fleet units. The implementation of this program established direct lines of communication and provided "one-stop shopping" sources for support necessary to meet fleet operational requirements.

Operational maintenance support and assistance is supplementary to that normally provided through type commanders and MOTU sources. The Fleet Liaison Office also provides advice and consultation services as requested by the operating forces in the following subject areas:

1. Material support information

2. Administrative procedures

3. Technical data

4. Resolution of interface and compatibility problems

5. Safety problems

6. Configuration and field change problems

7. Equipment maintenance

8. OJT and informal training not readily provided for elsewhere

A primary goal of the Fleet Liaison Program is to provide a single point-of-contact for the fleet in electronic matters by receiving, investigating, and evaluating problem areas, to include requests for technical assistance. The Fleet Liaison follow-up procedure, after investigating a problem area, is to recommend, initiate, and coordinate corrective actions.

Technical assistance requests for NAVELEX cognizant equipment should be made in accordance with fleet instructions to the nearest NAVELEX Fleet Liaison Office. The

following NAVELEX facilities have a fleet office:

1. Naval Electronic Systems Engineering Center

   NAVELEXSYSENGCEN — Charleston, S.C.

   — Portsmouth, Va.

   — San Diego, Calif.

   — Vallejo, Calif.

2. Naval Electronic Systems Engineering Activity

   NAVELEXSYSENG ACT — St. Inigoes, Md.

3. Naval Electronic Systems Engineering Activity Detachment

   NAVELEXSYSENGACT DET — Philadelphia, Pa.

4. Naval Electronic Systems Engineering Center Detachment

   NAVELEXSYSENGCEN DET — Mayport, Fla.

Naval Shore Electronics Engineering Activity

In addition to the NAVELEX field activities, the Naval Shore Electronics Engineering Activity (NAVSEEACT) exists to support the mission of shore activities. The function performed by NAVSEEACTs are basically the same as those discussed under NAVELEX Field Activities. NAVSEEACTs are located at Guam, Marianas Islands, Pearl Harbor, Hawaii, Subic Bay, R.P.I., and Yokosuka, Japan.

Naval Electronic Systems Command Detachment

The Naval Electronic Systems Command Detachment (NAVELEXSYSCOM DET), Patuxent River, Md., provides site support for the Antisubmarine Warfare Operations Center (ASWOC) and Force High-Level Terminal (FHLT) community. The functions performed by NAVELEXSYSCOMDET PAX are the same as those provided by other NAVELEX field activities.

NAVAL AIR DEVELOPMENT CENTER

The Naval Air Development Center, Warminster, Pa., provides many of the same services to the Carrier Antisubmarine Warfare Module (CV-ASWM) community as rendered by NAVELEX and NAVSEA facilities. The CV-ASWM Program Office at the Naval Air Development Center is tasked with providing logistics support, technical support, installation support, and many other services to support the CV-ASWM. Informal assistance may be received directly from the air development center. Points of contact and telephone numbers are listed in the "CV-ASWM Tableau," a quarterly newsletter published for the CV-ASWM community.

CASUALTY REPORTING

The Casualty Report (CASREP) has been designed to support the Chief of Naval Operations (CNO) and Fleet Commanders in the management of assigned forces. The effective utilization and support of U. S. Navy units and organizations require an up-to-date, accurate operational status for each unit. An important part of operational status is casualty information. The reporting of casualties results in operational commanders and support personnel being advised of the status of significant equipment malfunctions which may result in the degradation of a unit's readiness. In the past, many technicians and maintenance officers felt that submitting a CASREP was the same as putting themselves on report. The CASREP reports the unit's need for repair parts and/or technical assistance to correct the casualty. Once a CASREP is reported, CNO and Ships Parts Control Center (SPCC) receive a hard copy of the message. SPCC enters the CASREP messages into their computer and tracks the progress of the CASREP. Once every 24 hours, processed CASREP data are transmitted from SPCC to CNO and Fleet Command Centers (FCCs).

CASREPS

A casualty is defined as an equipment malfunction or deficiency which cannot be corrected within 48 hours and which: (1) reduces

the units ability to perform a primary mission, or (2) reduces the units ability to perform a secondary mission. All casualties which meet this criteria are reported by CASREPs.

There are four types of casualty reports:

1. Initial

2. Update

3. Correction

4. Cancellation

Initial Casualty Report (INITIAL)

An INITIAL casualty report identifies to an appropriate level of detail, the status of the casualty and parts and/or assistance required to correct the casualty. This information is essential to allow operational and staff authorities to apply resources at the proper priority.

Update Casualty Report (UPDATE)

An UPDATE casualty report contains information similar to that submitted in the "INITIAL" CASREP and provides changes to previously submitted information. Any changes to the situation, e.g., more parts or technical assistance needed, should be included in an UPDATE CASREP. UPDATE CASREP performs the function previously performed by the SITREP (Situation Report).

Correction Casualty Report (CORRECT)

A CORRECT casualty report is submitted by a unit when the equipment, which has been the subject of casualty reporting, is repaired and back in an operational condition. The CORRECT CASREP performs the function the CASCOR (Casualty Correction) performed previously.

Cancellation Casualty Report (CANCEL)

A CANCEL casualty report is submitted by a unit when the equipment, which has been the subject of casualty reporting, is scheduled to be repaired during an overhaul or other scheduled

availability. Outstanding casualties which will not be repaired during the availability shall not be canceled. Casualties in this category are subject to normal follow-up casualty reporting procedures as specified. The CANCEL CASREP performs the same function as the CASCAN, used previously.

CASREP References

For more complete information on preparation, format, and submission of CASREPs, refer to Operational Reports NWP-7 (current revision), Appendix B, and TYCOM directives.

SUMMARY

This chapter completes the *Data System Technician 1 & C* rate training manual. At the time of writing, all data used to prepare this manual was checked to ensure information was up-to-date and current. Instructions have been cited in many cases to provide additional information in the subject areas. To find the current applicable instruction, use the appropriate index of instructions; e.g., "5215" for OPNAV, COMNAVSURFPAC.

Technical directives or publication stock numbers may be found in the current copy of the *Navy Stock List of Publications and Forms*, NAVSUP PUB 2002.

GLOSSARY OF ABBREVIATIONS

ABBREVIATION	DEFINITION
AEL	Allowance Equipage List
AIC	Air Intercept Controller
AIMS	Airborne Identification Mobile System (Navy air traffic control radar beacon system identification friend or foe Mark XII system)
APL	Allowance Parts List
ASW	Antisubmarine warfare
ASWOC	Antisubmarine Warfare Operations Center
BVP	Beacon video processor
CAP	Combat Air Patrol
CASCAN	Casualty Cancel
CASCOR	Casualty Correction
CASREP	Casualty Report
CNO	Chief of Naval Operations
COMNAVELEXSYSCOM	Commander, Naval Electronic Systems Command

ABBREVIATION	DEFINITION
CONUS	Continental United States
CSAT	Combat System Alignment Test
CSITT	Combat System Interface Test Tool
CSOT	Combat System Operability Test
CV-ASWM	Carrier-Antisubmarine Warfare Module
DET	Detachment
DIP	Dual-in-line pack
DSOT	Daily System Operability Test
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
ESD	Electrostatic sensitive device
EW	Electronic warfare
FCC	Fleet Command Center
FHLT	Force High Level Terminal
FTC	Fleet Training Center
GFCS	Gun Fire Control System
GPIC	General Purpose Intercomputer POFA
GQ	General quarters
IC	Integrated circuit
IFF	Identification Friend or Foe
IMA	Intermediate Maintenance Activity
IPOFA	Integrated Programmed Operational and Functional Appraisal
LSI	Large Scale Integration
MFCS	Missile Fire Control System

ABBREVIATION	DEFINITION
MOTU	Mobile Technical Unit
MRC	Maintenance Requirement Card
NAVELEXSYSCOM	Naval Electronic Systems Command
NAVELEXSYSENGACT	Naval Electronics Systems Engineering Activity
NAVELEXSYSENGCEN	Naval Electronics Systems Engineering Center
NAVMAT	Naval Material Command
NAVSEA	Naval Sea Systems
NAVSEACENLANT	Naval Sea Support Center, Atlantic
NAVSEACENPAC	Naval Sea Support Center, Pacific
NAVSEASYSCOM	Naval Sea Systems Command
NAVSEASYSCOMDET	Naval Sea Systems Command Detachment
NAVSEEACT	Naval Shore Electronics Engineering Activity
NCS	Net control ship
OJT	On-the-job training
OCSOT	Overall Combat System Operability Test
PCB	Printed circuit board
PMS	Planned Maintenance System
POFA	Programmed Operational and Functional Appraisal
	Quality assurance
	Quick response
	Radiation hazard
RDF	Radio Direction Finder
RFI	Ready for issue

ABBREVIATION	DEFINITION
SEMCIP	Shipboard Electromagnetic Compatibility Improvement Program
SIT	System Interface Test
SITREP	Situation Report
SM&R	Source, Maintainability and Recoverability
SOT	System Operability Test
SPCC	Ships Parts Control Center
SSC	Service School Command
STO	Systems Test Officer
SWC	Ship weapons controller
TACAN	Tactical Aid to Navigation
TDS	Tactical Data System
TDT	Target Data Transmitter
TSTP	Total Ship Test Program
TYCOM	Type Commander
2M	Miniature/Microminiature

CHAPTER 2

NAVY COMMAND AND CONTROL SYSTEM (NCCS)

For years the geographical scope of warfare and the mobility of forces have increased. However, the ability to collect information about a battle in a way that would present and transmit a coherent picture to a remote commander failed to keep pace. Land force commanders continued to move flags about on charts or sand tables to represent the combat theater. They used bits and pieces of intelligence data about enemy dispositions and operational reports from friendly forces. Naval and Air Defense Commands used similar methods to aid in monitoring and controlling their forces. It was commonly accepted that, all other factors being equal, the commander with the most accurate and timely information, and the best communications to issue commands and to support the feedback of information would have the best chance of winning. This led to a continuing operational requirement for increased information and better communications.

In more recent times, as computers were used for more diversified tasks, the potential to make use of them in command and control systems was investigated. It was determined that the capabilities of digital computers, and the expanded data handling capabilities of current communications systems were suitable for use in a command and control system. The World Wide Military Command and Control System (WWMCCS) was the result of this investigation and research. In 1973, during the Middle East crisis, the United States was able to notify all of its Unified and Specified Commands of a possible unilateral movement by an outside party in less than three minutes.

WWMCCS has existed since the early 1960's as a loose confederation of relatively autonomous systems. The Secretary of Defense recently directed that WWMCCS be developed into an integrated system with one primary mission—to provide command and control support to the President and the Secretary of Defense (SECDEF). As a secondary mission, WWMCCS supports the requirements of the Joint Chiefs of Staff (JCS), military service headquarters, unified and specified commanders, service component commanders, and DOD agencies. The command and control systems provided to the Fleet Commanders in Chiefs (FLTCINCs), must be responsive to the requirements of WWMCCS. Further, since it may be necessary at times to address directives from the President and SECDEF to individual force elements engaged in critical operations, all Navy command and control systems must be compatible with WWMCCS.

Three basic development criteria exert strong influence on the design of Navy command and control systems. Navy systems must:

● Be consistent with the policy and architecture of the WWMCCS and be compatible with it

● Recognize the existence of a large number of independent, single purpose systems already in service which have to be brought together and integrated

● Support the requirements of Navy tactical commands as their primary considerations

In 1975 a Navy Command and Control Architecture Group was formed to analyze command and control requirements and to formulate guidance for the development of an integrated Navy system. The Group compiled a list of 166 systems currently operating in support of command and control (C^2) requirements. A decision was made to integrate the outputs of
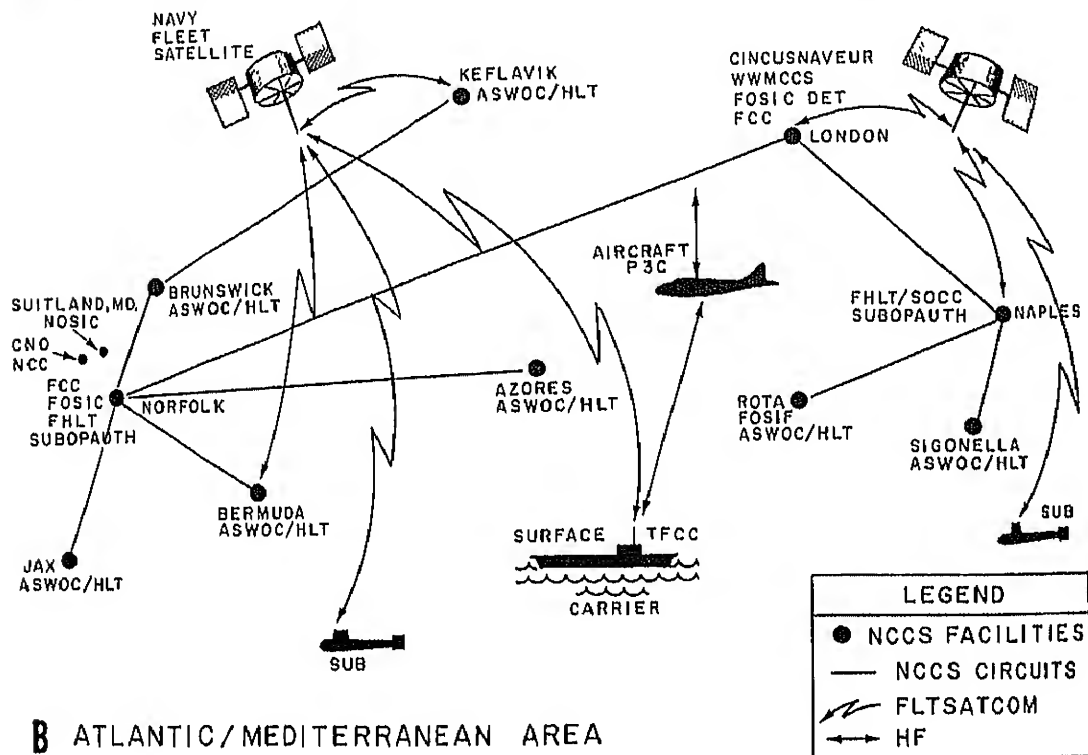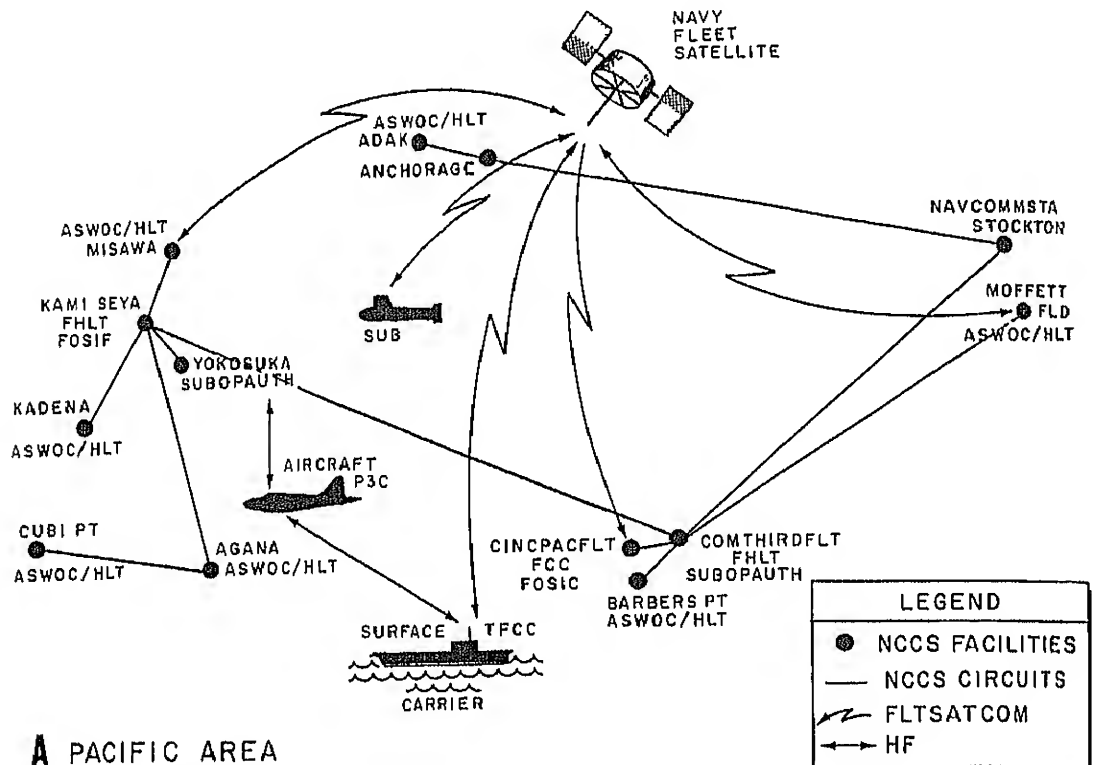
Figure 2-1.—NCCS communications concept of operations.

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certain of these systems rather than to try and design a completely new C^2 system. The Architecture Group identified two primary nodes ("nodes" are the command centers directly serving operational commanders) for the Navy's C^2 capability as:

● Fleet Command Centers (FCCs)—ashore sites at CINCLANTFLTHQ, CINCPACFLTHQ, CINCUSNAVEUR HQ, and CNO HQ

● Tactical Flag Command Centers (TFCCs)—afloat centers in appropriate flagships

The FLTCINCs are the key commanders in the Navy's C^2 architecture. Their headquarters are the points of interface upward via WWMCCS to national command authority and downward through the TFCC to the forces afloat.

Fifteen Navy systems were included in the baseline capability for support of the FCC/TFCC nodes. DSs are involved in the maintenance of six of these systems. This chapter will discuss the Navy Command and Control System (NCCS) and three of the component systems with which DSs are involved:

1. The Antisubmarine Warfare Operations Center (ASWOC)
2. The Force High Level Terminal (FHLT)
3. The Carrier Antisubmarine Warfare Module (CV-ASWM)

NAVY COMMAND & CONTROL SYSTEM (NCCS)

The Navy Command & Control System (NCCS) is a command system and a command support system. It is composed of two nodes (ashore and afloat) and provides the primary interface with WWMCCS via the major ashore nodes. Figure 2-1A depicts the concept of operations of the NCCS for the Pacific area. Figure 2-1B depicts the concept of operations of the NCCS for the Atlantic/Mediterranean area.

The NCCS is based on an organized, operational command hierarchy with four major ashore nodes and a number of major afloat nodes. The ashore nodes support the command centers of CINCLANT/CINCLANTFLT, Norfolk, Virginia; CINCUSNAVEUR, London, England; CINCPACFLT, Makalapa, Hawaii; and CNO, Washington, DC. The major afloat nodes support the embarked Officer in Tactical Command (OTC) of a battle group in a geographical area. Within the individual command structures are subordinate facilities supporting the NCCS. The major ashore facilities are the FLTCINC Command Centers (FCCs), which provide the primary interface between WWMCCS and the NCCS. The NCCS ashore will provide the afloat facilities with all the available, relevant, evaluated information on enemy, friendly, and ownforces during all conditions of fleet operations.

The NCCS is a network of facilities located at key geographic positions and aboard major combatants, designated as flagships in support of the OTC. Table 2-1 summarizes the NCCS ashore locations. The TFCCs, the major afloat node, will be located on CVs, CVNs, CGs, CGNs, and LCCs.

Within the NCCS ashore are several systems which perform functions useful to the fleet/force CINCs. They are OSIS, SUBOPAUTH, and ASWCCCS. OSIS (Ocean Surveillance Information System) is a shore-based supporting system that evaluates all-source information on ocean surveillance targets of interest. The OSIS program was implemented to automate the receipt, processing, and dissemination of information to maintain a world-wide, all-source data bank.

The SUBOPAUTHs (Submarine Operations Authority) are the principal advisors to the Fleet CINCs on submarines at sea. They control submarine operations, missions, and mission duration. They also monitor the operations of other naval forces and coordinate with other naval operating commanders to ensure submarine safety. The SUBOPAUTH is the ashore node for communications with submarines. Communications are performed by means of elf (extremely low frequency) and lf (low frequency) broadcasts, and by means of SSIXS (Subsurface Information Exchange System). SSIXS is a digital satellite link between submarines and SUBOPAUTH facilities. SUBOPAUTH facilities are being upgraded with the Shore Targeting Terminal (STT). An expanded mission for SUBOPAUTHs is providing Over the Horizon Targeting (OTH-T) support to assigned submarines. The STT hardware has been installed to support this requirement.

Table 2-1.—NCCS-Ashore Locations

NCCS NODE DESCRIPTIONS	COMMAND SUPPORTED	LOCATION
NCC/NWSS	CNO	WASHINGTON, DC
FCC/FHLT/OSIS (FOSIC)/NWSS	CINCLANT/CINCLANTFLT	NORFOLK, VA
FCC/OSIS (FOSIC)/NWSS	CINCPACFLT	PEARL HARBOR, HI
FCC/OSIS (FOSIC)/NWSS	CINCUSNAVEUR	LONDON, ENG
SUBOPAUTH	COMSUBLANT	NORFOLK, VA
SUBOPAUTH	COMSUBPAC	PEARL HARBOR, HI
SUBOPAUTH	COMSUBGRU EIGHT	NAPLES, ITALY
SUBOPAUTH	COMSUBGRU FIVE	SAN DIEGO, CA
SUBOPAUTH	COMSUBGRU SEVEN	YOKOSUKA, JAPAN
FHLT	COMTHIRDFLT	PEARL HARBOR, HI
FHLT	CTF-67	NAPLES, ITALY
FHLT	CTF-72	KAMI SEYA, JAPAN
OSIS (FOSIF)	COMSIXTHFLT	ROTA, SPAIN
OSIS (FOSIF)	CONSEVENTHFLT	KAMI SEYA, JAPAN
OSIS (NOSIC)	CNO/ALL NAVY	SUITLAND, MD
ASWOC/HLT	CTG 24.1	KEFLAVIK, ICELAND
ASWOC/HLT	CTG 24.2	LAJES, AZORES
ASWOC/HLT	CTG 24.3	BERMUDA
ASWOC/HLT	CTG 24.4	BRUNSWICK, ME
ASWOC/HLT	CTG 24.5	JACKSONVILLE, FL
ASWOC/HLT	CTU 67.1.2	SIGONELLA, ITALY
ASWOC/HLT	CTU 67.2.2	ROTA, SPAIN
ASWOC/HLT	CTG 32.1	MOFFETT FIELD, CA
ASWOC/HLT	CTG 32.2	BARBERS POINT, HI
ASWOC/HLT	CTG 32.3	ADAK, AK
ASWOC/HLT	CTU 72.2.6	KADENA, OKINAWA
ASWOC/HLT	CTG 72.3	CUBI POINT, RPI
ASWOC/HLT	CTG 72.4	MISAWA, JAPAN
ASWOC/HLT	CTG 72.5	AGANA, GUAM
ASWOC/HLT	CTG 72.8	DIEGO GARCIA

Ancillary equipment required to effect communications interface to this system will also be installed.

ASWCCCS (Antisubmarine Warfare Center Command & Control System) is a shore-based system designed to provide an integrated, near real-time command and control capability for ASW forces to evaluate and carry on attacks on submarine contacts on an ocean-wide basis.

The Navy WWMCCS Software Standardization (NWSS) consists of major software components which allow the Navy Command and Control users access to WWMCCS data. It supports the NCCS ashore nodes at CNO and the FLTCINCS. In addition, NWSS data is available at FHLT sites via dedicated terminals, at COMSUBLANT via a dedicated alpha-numeric terminal, and at SUBOPAUTHS via the Graphic Analysis and Display System (GADS) (both alphanumeric and graphic display). NWSS processes data in the areas of Naval Status of Forces (NSOF), Unit Tracking (UNITRACK), ASW, and Blue Force Characteristics File (BFCF). It provides for automatic receipt, processing, storage, and transfer of information reported via the Navy Reporting Structure (NRS) operational report messages. NWSS provides error detection and correction capabilities.

ANTISUBMARINE WARFARE CENTER COMMAND & CONTROL SYSTEM

ASWCCCS was developed with the following purposes in mind:

● To provide more timely and accurate ASW related data to ASW Force and sector commanders

● To optimize communications between and among the ASW Force and sector commanders

● To improve automatic data processing support available to the ASW Force and sector commanders

Two major components make up the ASWCCCS:

1. The ASWOC/HLT (Antisubmarine Warfare Operations Center/High-Level Terminal)

2. The FHLT (Force High-Level Terminal)

The FHLT provides the facility for the Force ASW Commander to communicate directly to the Sector ASW Commanders located at the ASWOC/HLT. The overall block diagram of the interconnection of the FHLTs, ASWOC/HLTs, and the FCCs is shown in figure 2-2. As shown in figure 2-2, the ASWOC/HLT is the lowest building block of the command pyramid. Each ASWOC/HLT provides data to the Force Commander via an FHLT site. This data is also sent to the Fleet Commanders (FCC), and on to the NCSC (Navy Command Support Center), where CNO has access to ASWCCCS data and recommendations. The function, configuration, and operation of the ASWOC/HLT and the FHLT will be covered in greater depth later in this chapter.

ASWCCCS Intersite Communications

Intersite communications for the ASWCCCS consist of a secure data network and a secure voice network. These networks provide the man-to-man and machine-to-machine communications paths needed to carry out the role of the ASWCCCS.

The secure data network uses data quality circuits at a 2400-9600 baud rate to transfer data between sites. It uses various media such as satellite communications, microwave, submarine cable, and landlines to transfer data between sites. The multiplexers, modems (modulator-demodulators), and cryptographic equipment used in the secure data network provide the interface, encryption, and selection functions required for the transfer of data from site-to-site. The Communications Line Interface (CLI) and the Programmable Terminal Control Interface (PTCI) are used to transfer data from site-to-site on their separate channels.

The secure voice network uses digitized, 2400 baud voice quality circuits to provide secure voice communications between various ASWCCCS sites. The media (microwave, satellite, and so forth) are often the same as for secure data, and the equipment used is the same as for the secure data network. The heart of the secure voice network is the Automated Digital Switch (ADS). The ADS is a digitized voice switching center which provides direct dialing in the secure voice

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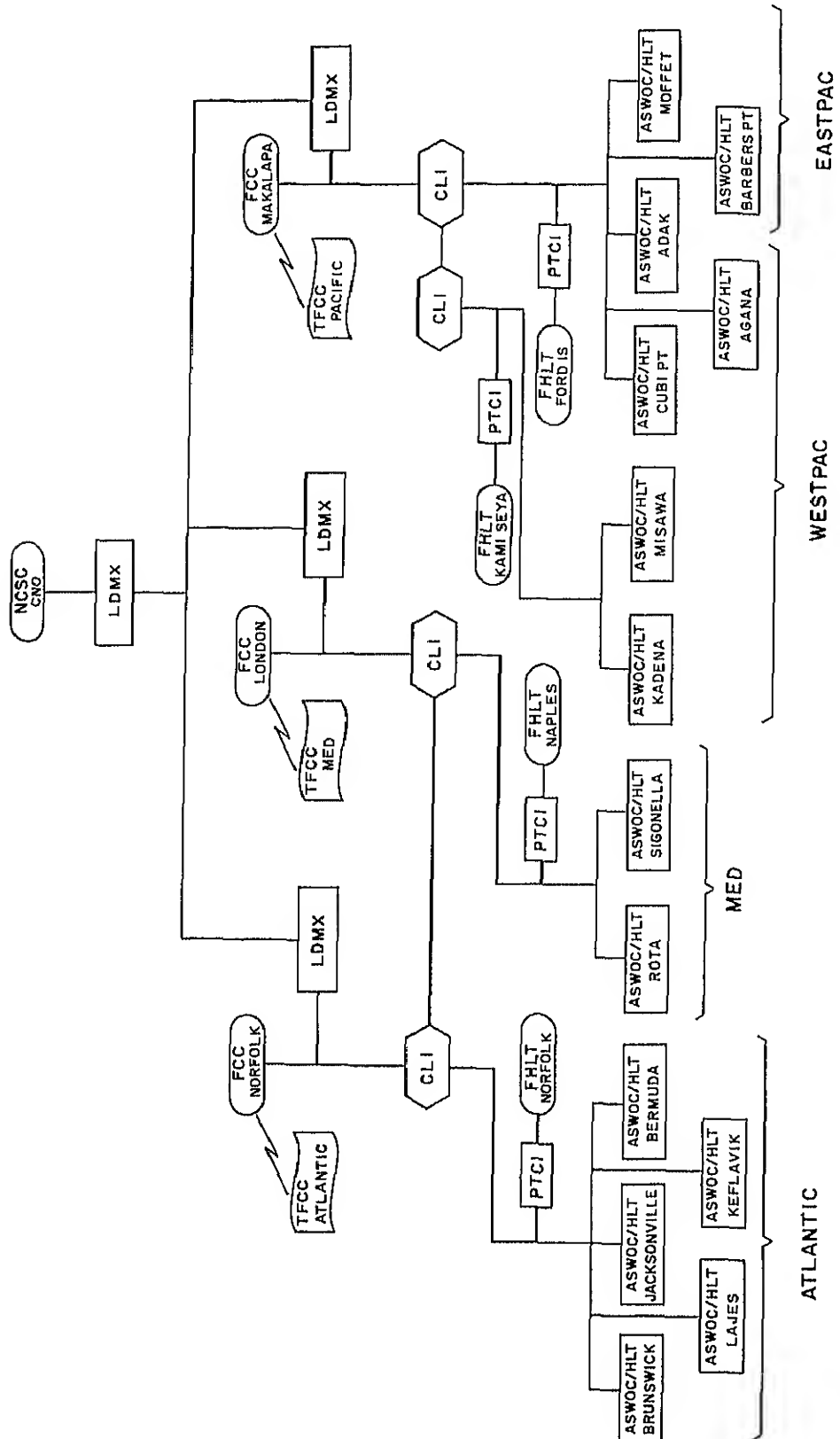
network. Precedence preemption is available in this system, and conference calls may be set up among various sites. There is at least one secure voice subscriber phone at each site.

TACTICAL FLAG COMMAND CENTER (TFCC)

The Tactical Flag Command Center is the battle station of the OTC and the primary afloat mode of the NCCS. The TFCC is the space where the OTC carries on command and control functions. It provides designated flagships with a tactical information and communications center for the OTC. Figure 2-3 shows the integration of the TFCC into the ships systems. The systems providing data to the TFCC are the CV-ASWM, SSES, CVIC, and NTDS. These systems have a data base which provides the overall picture to the OTC. From this data, a decision can be made as to the deployment of offensive or defensive forces.
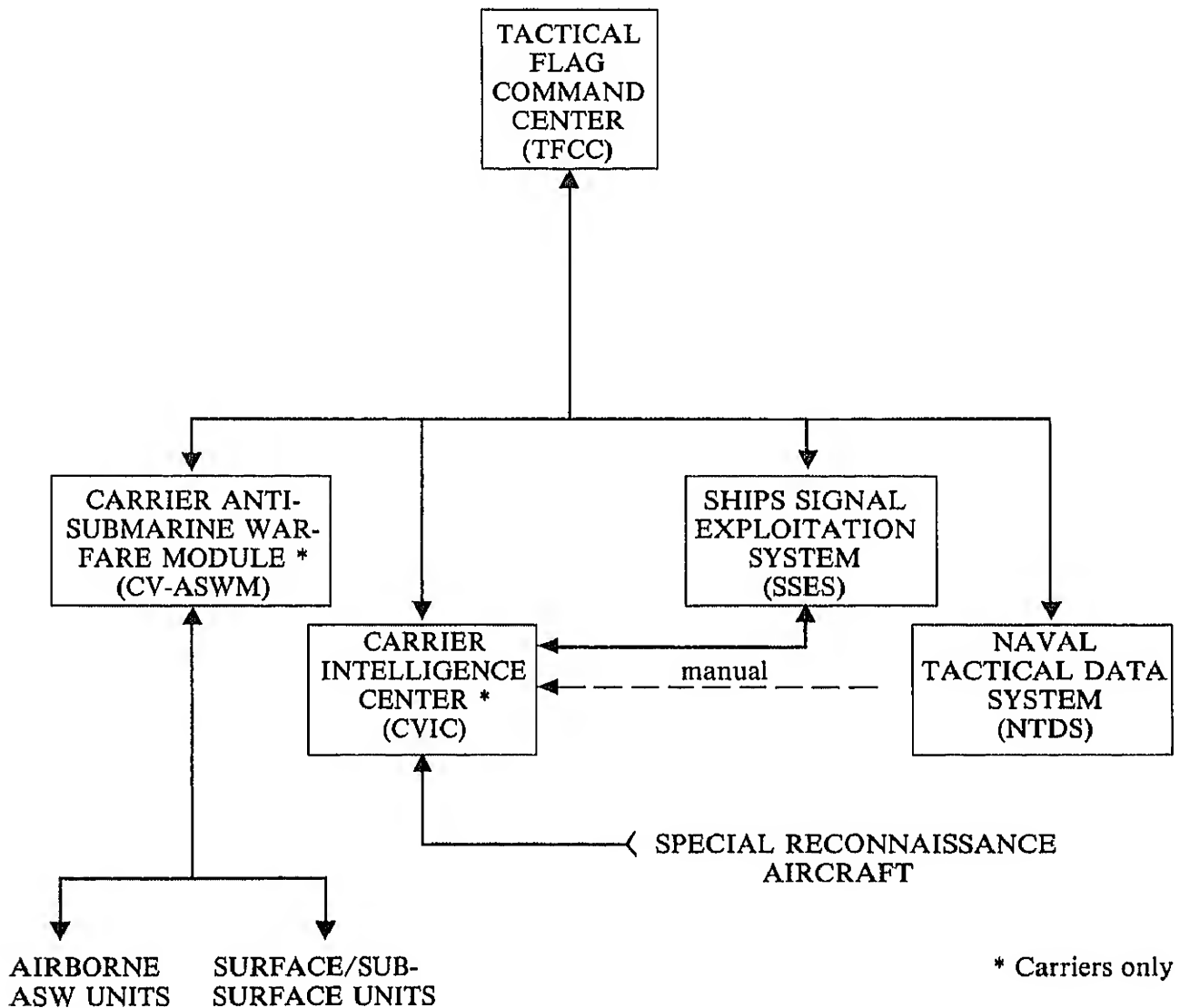
Figure 2-3.—Tactical Flag Command Center (TFCC) shipboard integration.

Carrier Antisubmarine Warfare Module (CV-ASWM)

The Carrier-Antisubmarine Warfare Module (CV-ASWM) provides the same afloat function as the landbased ASWOC. The CV-ASWM gives the carrier a highly advanced mission brief and debrief capability that matches the newest airborne Antisubmarine Warfare (ASW) weapon systems. The CV-ASWM gives both real-time and delayed analysis of ASW data from selected aircraft, before, during, and after their flight. This capability enables the carrier to locate and track enemy subs better and faster than before. It also automatically provides the flight crews with more data to make their jobs easier and faster. It enhances the multi-mission role of today's modern carriers. The CV-ASWM will be discussed in greater depth later in this chapter.

Naval Tactical Data System (NTDS)

The Naval Tactical Data System (NTDS) is a real-time command and control system designed to control the major weapons systems aboard combatant ships. It is the pioneer of the digitally controlled systems used in today's modern naval ships. Additional information on NTDS may be found in *Data System Technician 3 & 2*, Vol. 2, NAVEDTRA 10201 (Series) and *Data System Technician 1 & C*, Vol. 1, NAVEDTRA 10203 (Series). NTDS provides information to the TFCC obtained from ships sensors and from picket ships located around the task force perimeter. NTDS data may be also manually provided by magnetic tape to the Carrier Intelligence Center (CVIC).

Carrier Intelligence Center (CVIC)

The Carrier Intelligence Center (CVIC) is a computerized intelligence processing and generation system. The system processes locally collected tapes and film and intelligence information from other activities. Existing files are updated and new files are generated in support of tactical operations. The CVIC provides support for tactical naval operations by integrating up-to-the-minute tactical intelligence with national and fleet-produced data base intelligence information. Multisensor intelligence integration and data correlation, information retrieval, tactical updating, and order-of-battle generation a portions of the capabilities provided to the TFC by the CVIC.

Ships Signal Exploitation System (SSES)

The Ships Signal Exploitation System provid interception and analysis of radio frequent messages transmitted by unfriendly or hosti forces. It provides the TFCC with intercep information derived from radio message traff of hostile forces.

ANTISUBMARINE WARFARE OPERATIONS CENTER/HIGH LEVEL TERMINAL

The Antisubmarine Warfare Operation Center/High Level Terminal (ASWOC/HLT) i a combination of three independent supportin systems: Land-based Tactical Support Cente (VP-TSC), ASW Support Communication (ASCOMM), and the High Level Terminal (HL T of the ASWCCCS. The ASWOC/HLT is display-augmented, computerized command and control system designed to support Sector ASW Commanders. The ASWOC supports ASW mission planning, mission briefing, and debrief ing by providing information from local data base, as well as from the ASWCCCS data base at the Central Site (CS). A query/response package provides access to the CS for historical data and for processing and analysis capabilities not locally available. The dedicated ASWCCS data network increases coordination and communication between superior and subordinate units for the shore based mode. The Data Link (Link 11) provides the same capability for the onstation platforms (P-3C or S-3A aircraft). The user's data analysis capability is enhanced by interactive geographic and alphanumeric display Computer-aided construction of RAINFORM messages and their delivery over a dedicated communications network improves the timely reporting of mission results. Sixteen ASWOC/HLTs have been installed under the ASTACS (Antisubmarine Tactical Analysis Centers Systems) program.

ASWOC PHYSICAL CONFIGURATION

The ASWOC is constructed in two physical configurations:

1. Fixed site
2. Modular site

The capability, equipment configuration, and system functions of these two types of sites are the same. Fixed and modular sites are located both in CONUS and abroad. The easily-relocatable modular units provide for a greater strategic flexibility.

ASWOC EQUIPMENT CONFIGURATION

The ASWOC equipment performs various roles needed to enhance the performance of the ASW mission. Physically the ASWOC system is divided into four subsystems:

1. Automatic Data Processing (ADP) Subsystem
2. Display Subsystem
3. Analysis Subsystem
4. Communications Subsystem

Each subsystem works in conjunction with the other subsystems to perform its unique role which contributes to the overall mission of the ASWOC. A simplified block diagram of the ASWOC system is shown in figure 2-4, a foldout at the end of this chapter.

ASWOC Automatic Data Processing (ADP) Subsystem

The ASWOC ADP Subsystem provides the central processing capability for all ASWOC system data base functions. The ASWOC ADP subsystem is comprised of the following hardware in the quantities indicated.

1. Avionics Unit Computer CP-901/ASQ-114(V) (1)
2. Microprogrammable Processor CDC Model 560633A (1)
3. Disk Storage Unit CDC Model 567018A (1)
4. Magnetic Tape Transport Interface Compunetics 5670 (1)
5. Magnetic Tape Transport Potter Model SC 1051 (4)
6. High Speed Printer Data Products Model 4300 (1)
7. Digital Magnetic Tape Interface Compunetics Model 22500 (1)
8. Digital Magnetic Tape Unit RD-348/ASH (1)
9. Digital Input/Output Multiplexer Compunetics Model 35620 (1)
10. Signal Data Buffer Compunetics Model 5610A (4)
11. Compunetics Keyset (5)
12. Synchro-to-Digital Converter Compunetics Model 7067C01 (1)
13. Central Power Supply Compunetics Model 5691 (1)

The ASWOC system block diagram (fig. 2-4) shows the interface of the ADP Subsystem to the Display, Analysis, and Communications Subsystems.

AVIONICS UNIT COMPUTER CP-901/ASQ-114(V).—The Avionics Unit Computer CP-901/ASQ-114(V) (CP-901) (fig. 2-4) is the ASWOC unit computer. It is the same type of computer as the ones used in the P-3C patrol aircraft. This computer performs the central processing, storage, and input/output functions for the ASWOC system. The CP-901 has 16 input channels and uses the signal data buffers to provide 16 output channels to the various peripheral equipment. These online peripheral equipment are under the direct control of the computer and are operated in response to either a manual entry command or a program requirement. The computer provides all display formatting, control for the data link, and message reports to various senior commands. The computer also provides a level of confidence in system operation by periodically executing a series of equipment test programs.

The CP-901 contains 65K of 30-bit core memory and is augmented by an 11.1 megaword, 32-bit word length, disk storage unit.

MICROPROGRAMMABLE PROCESSOR CDC MODEL 560633A.—The microprogrammable processor (MPP) (fig. 2-4) functions as a controller for the disk storage unit. The MPP is divided into five basic units: read-only memory (ROM), interface section, addressing and control section, arithmetic and logic section, and the transform matrix section. The ROM contains a 32-bit, 512-word firmware Read Start Program which cannot be altered by the operator. This program controls the function of the MPP as an interface device, controller, and buffer for up to four disk storage units.

DISK STORAGE UNIT CDC MODEL 567018A.—The disk storage unit (DSU) (fig. 2-4) is a mass memory unit using magnetic disk packs. The DSU is a flexible unit designed to fulfill mass memory requirements. The primary purpose of the DSU is to store and maintain large quantities of data until recalled by the computer. Whenever data is required by an operator entry or a program function, it is read from the disk, utilized, and then rewritten on the disk. The disk pack is capable of storing approximately 507.5 megabits of data. The DSU provides the capability of supplementing the software programming and data storage capacity of the CP-901 computer. It provides a method of random access for the rapid storage and retrieval of data. Additional information on the operation of disk storage units may be found in *Digital Computer Basics*, NAVEDTRA 10088 (Series) and *Data Systems Technician 3 & 2*, Vol. 2, NAVEDTRA 10201 (Series).

MAGNETIC TAPE TRANSPORT INTERFACE COMPUNETICS MODEL 5670.—The Magnetic Tape Transport Interface (MTTI) Compunetics Model 5670 (fig. 2-4), is required to format the data from tapes into a computer language or into discrete lines for the high speed printer.

The MTTI provides the following functions:

1. Establishes communications between the magnetic tape transports (MTTs) and the unit computer

2. Reformats data words between the CP-901 and the MTTs into words which can be used by each device

   a. Converts 6-bit character words from the MTT into 30-bit computer words

   b. Converts 30-bit computer words to 6-bit MTT words

3. Establishes communication between the MTTs and the high speed printer (HSP), formatting 6-bit character words from the MTTs to one line of 120 six-bit words for the HSP

4. Establishes communications between the CP-901 and the HSP, converting 30-bit computer words to one line of 120 six-bit words necessary for the HSP

MAGNETIC TAPE TRANSPORT POTTER MODEL SC 1051.—The Magnetic Tape Transport Potter Model SC 1051 (fig. 2-4) provides the capability of reading data into, or writing data from, the data base via the computer. Data from the tapes is placed in the DSU or reduced to hard copy by the high speed printer.

Some of the functions of the MTT include:

1. Reading data into the system data base
2. Reading into the replay data base

   a. Mission replay tapes of digital data extracted from the computer installed on the P-3C aircraft

   b. Manual plot entry (MPE) generated extraction tapes

3. Writing and reading the MPE generated data tape via the CP-901 computer

4. Writing data that has been retrieved from the system data base onto magnetic tape

HIGH SPEED PRINTER DATA PRODUCTS MODEL 4300.—The High Speed Printer (HSP) Data Products Model 4300 (fig. 2-4) provides a means of producing a hard copy of data extracted from the data base or from data extraction tapes. The HSP contains all the electrical and mechanical components required to:

1. Accept and store one line of data, serially by character, up to a maximum of 120 characters

2. Print up to 1000 lines per minute on multiple-part fanfold paper, or on tabulating stock

3. Provide vertical spacing to allow either six or eight lines per inch

4. Position the paper for the next line of print

The output to the HSP is provided via the MTTI buffer memory from the CP-901 computer or a Potter MTT.

The HSP provides a permanent hard copy of data presented on the DVC tableau display. The HSP also provides amplifying legends (supplemental data) to the hard copy plot reproduced on the X-Y plotter or displayed on the DVC situation display. It is a means of providing a hard copy of data presented on the communications data terminal.

DIGITAL MAGNETIC TAPE INTERFACE COMPUNETICS MODEL 22500.—The Digital Magnetic Tape Interface (DMTI) Compunetics Model 22500 (fig. 2-4) provides a means of converting data from mission tapes to a format usable by the CP-901 computer. It provides a means of inputting aircraft mission tapes into the system data base. The DMTI also acts as an intermediate buffer between the MTTI and the CP-901 computer.

Mission tapes from P-3C aircraft are formatted into 30-bit computer words and are routed either to the CP-901 computer or through the MTTI to the HSP. The HSP provides a hard copy of P-3C mission data. The CP-901 uses the mission data for debrief functions after a mission has been completed.

DIGITAL MAGNETIC TAPE UNIT RD-348/ASH.—The Digital Magnetic Tape Unit (DMTU) RD-348/ASH (fig. 2-4) allows S-3A mission tapes to be played back and inserted into the data base. Data from the DMTU is transferred to the DMTI where it is transferred to the CP-901 computer or the MTTI. The data from the mission tapes is used by the CP-901 computer for debriefing, updating the data base, and briefing crews for future missions. The MTTI then transfers the data to MTTs for recording or to the HSP where a hard copy of the mission data is produced.

DIGITAL INPUT/OUTPUT MULTIPLEXER COMPUNETICS MODEL 35620.—The Digital Input/Output Multiplexer Compunetics Model 35620 (fig. 2-4) is commonly referred to as the DIM/DOM. The DIM/DOM serves as a conversion and multiplexing device which permits communications between a number of keysets and the CP-901 computer. The DIM/DOM provides conversion and multiplexing functions for the following keysets:

1. Direct View Console (DVC) Keysets
2. Sonic Keysets
3. Manual Plot Entry (MPE) Keyset

The DIM/DOM receives 9-bit words from the peripheral equipment (keysets) and adds an identification code to form a 30-bit computer word. It also receives a 30-bit word from the computer, interprets the ID code, and routes a 9-bit word to the correct keyset. The DIM/DOM allows one computer I/O channel to be used by a number of low data rate devices.

SIGNAL DATA BUFFER COMPUNETICS MODEL 5610B.—The Signal Data Buffer Compunetics Model 5610B (fig. 2-4) is commonly referred to as the SDB. The SDBs provide a means of distributing the CP-901 computer outputs to the specified peripheral equipment.

SYNCHRO-TO-DIGITAL CONVERTER COMPUNETICS MODEL 7067C01.—The Synchro-to-Digital Converter Compunetics Model 7067C01 (fig. 2-4) is a conversion and multiplexing device. It allows communication between the various synchro devices located in the ASWOC and the CP-901 computer. The synchro transmissions are primarily track ball, strobe roller, and HYFIX information. The S/D converter performs the following functions:

1. Receives synchro transmitter signals
2. Converts the synchro signals into a 14-bit word with a channel ID code
3. Stores the conversion words and ID codes in holding registers
4. Transfers selected channel digital data to the CP-901, when directed to do so by the computer

The S/D converter performs a function similar to the DIM/DOM for low data rate synchro signals.

COMPUNETICS KEYSETS.—The Compunetics keysets, commonly referred to as keysets, (fig. 2-4) provide a means of entering data into the CP-901 from the DVCs or other stations. The keysets are composed of the following units:

1. Keyboard Assembly Compunetics Model 5643—allows entry of data into system
2. Keyset Interface Compunetics Model 5642—changes the key data to a parallel data format for the computer or computer data to data usable at the keyboard
3. Keyset Power Supply Compunetics Model 5694—provides correct operating voltages to the keyboard and keyset interface

CENTRAL POWER SUPPLY COMPUNETICS MODEL 5691.—The Central Power Supply Compunetics Model 5691 (not shown) provides power and control for the following equipment:

1. Magnetic Tape Transport Interface (MTTI)
2. Synchro-to-Digital Converter
3. Signal Data Buffers
4. Digital Input/Output Multiplexer (DIM/DOM)
5. X-Y Plotter Interface

ASWOC Analysis Subsystem

The ASWOC Analysis Subsystem provides a means of analyzing data from sonobuoys, data links, and mission data tapes. The analysis subsystem is composed of the following equipment and systems:

1. Fast Time Analyzer System Rockwell Model VP
2. Manual Plot Entry Compunetics Model 5652
3. Digital Tablet Interface Compunetics Model 2020-1
4. X-Y Plotter CCI Model 1136
5. Plotter Interface Compunetics Model 5681

These units provide a display of data or provide a means of inputting data into the CP-901 computer for processing.

FAST TIME ANALYSIS SYSTEM ROCKWELL MODEL VP.—The Fast Time Analysis System Rockwell Model VP (fig. 2-4) is commonly referred to as the FTA. The FTA provides a means of analyzing sensor data and determining the identification and other characteristics of a suspected contact. The FTA is normally maintained by the Aviation Warfare Technician rating. Details of the exact operation of the FTA system and sensor inputs are classified.

MANUAL PLOT ENTRY COMPUNETICS MODEL 5652.—The Manual Plot Entry Compunetics Model 5652 (fig. 2-4) is normally referred to as the MPE. The MPE and its associated interface provide the means for manually entering data, primarily generated aboard non-P-3C aircraft, into the ASWOC system. The MPE unit consists of:

1. A coordinate digitizer
2. A stylus for selecting points on the coordinate digitizer
3. A console with associated electronics
4. A power supply module

The MPE unit is used in conjunction with an MPE interface unit, a keyset, a keyset interface unit, and a keyset power supply. The MPE provides the capability of entering the ASW data which is collected by non-P-3C aircraft. The data obtained by these aircraft can then be displayed and analyzed in the same manner as data from a P-3C aircraft. Also, the MPE provides a means of entering patrol zone areas, BT datum areas, grids, and geographic displays into the data base.

The functions of the MPE components are as follows:

1. Coordinate Digitizer—provides a translucent tablet containing a digital encoding matrix, upon which slides or films can be projected, or maps and tactical charts may be overlayed
2. Stylus—provides a probe which picks up coordinates of the digital coding matrix
3. Console—provides a working area and an enclosure for necessary electronics

4. MPE Interface Unit—provides a means by which the plot (X,Y) data can be entered into the computer and provides communications between the keyset and the computer

5. Keyset—provides for entry of data into the computer or data base

X-Y PLOTTER CI MODEL 1136 AND PLOTTER INTERFACE COMPUNETICS MODEL 5681.—The X-Y Plotter CCI Model 5652 (fig. 2-4) is a high-speed, two-axis recorder. It is designed to plot one variable against another. It can produce:

1. Line drawings such as patrol zones and BT areas
2. Pertinent symbology, numbers, and letters

The plotter operates either in an automatic or manual mode. In the automatic mode, output data from the computer are decoded by the plotter interface to provide the correct X-axis and Y-axis control signals to the plotter. The Y-axis is produced by the lateral movement of the pen carriage. The X-axis plot is produced by the rotary motion of the drum. Outputs from the plotter interface are also used to select and control the raising or lowering of one of the three pens to the plot surface. The plotter has the capability of reversing and changing axis. The plotter provides a hard copy plot of graphic information such as sonobuoy deployment and tactical situations contained in the system data base. A plot of all tactical data displayed on a DVC situation display can be reproduced on the plotter.

ASWOC Display Subsystem

The Display Subsystem is comprised of direct view consoles (DVCs), related displays, and data display terminals. These devices provide the capability to access, scan, edit, and update the ASWOC System data base. They also portray, in situation and/or tableau form, selected data from the system data base. A large screen display of the console presentation can be projected for use in command and in brief/debrief functions. The Display Subsystem also provides access and display of data from the WWMCCS computer through the ASWCCCS high level terminal (HLT) interaction functions. The DVC operator can

format and edit messages and control real-time exchange of tactical data to and from mission aircraft or surface forces through Link 11.

The Display Subsystem consists of the following major equipment in the quantities indicated:

1. Direct View Console Aydin Model 8400 (5)
2. Display Interface Unit Aydin Model 8420 (3)
3. Large Screen Display Aydin Model 8060 (2)

The Display Subsystem is made up of three display chains, each of which has a dedicated output channel from the CP-901 computer (fig. 2-4). A display chain is composed of a DVC interface, a buffer memory, a display power supply, and one or two DVCs.

DIRECT VIEW CONSOLE AYDIN MODEL 8400.—The Direct View Console Aydin Model 8400 (fig. 2-4) is commonly called a DVC. A typical DVC is composed of the following subunits:

1. Two Crt Units
2. Strobe Roller
3. Track Ball
4. Character Generator
5. Function Generator
6. Alphanumeric Keyboard
7. Keyset Interface
8. LSD Control Panel

The functions of the major components comprising the DVC are as follows:

1. The left crt provides:

a. The presentation of ASWOC symbology representing information such as sonobuoy position, contact, fix, and track. The symbology is generated either by the operator or by a software program (upper three-quarters of crt)

b. The presentation of graphic information contained in the data base (upper three-quarters of crt)

c. The presentation of tactical plots generated by mission replay (upper three-quarters of crt)

d. The presentation of cueing sequences, alerts, and messages (lower quarter of crt)

2. The right crt provides:

a. The presentation of tableau information from magnetic extraction flight tapes, processed analog acoustic tapes, data link, ASW formatted messages, and tableau data entered by the operator (upper three-quarters of crt)

b. The presentation of alphanumeric and symbology verification of operator entries (lower quarter of crt)

3. The console keyset provides:

a. Access to and update and use of the ASWOC data base

b. Capability of performing specific task assignments through the use of operational software programs

4. The alphanumeric keyboard provides a means of entering data into the ASWOC data base

5. The strobe roller provides a means of vertically positioning a strobe symbol on the tableau (right crt) display

6. The synchro track ball provides a means of vertically positioning the hook symbol on the situation (left crt) display

7. The keyset interface unit provides a means by which the DVC operator can communicate with the computer

8. The image generators, consisting of the function and character generators, produce the

LARGE SCREEN DISPLAY AYDIN MODEL 8060.—The Large Screen Display (LSD) Aydin Model 8060 subsystem projects on a large screen the data selected and displayed on the DVC situation and tableau crt's. This function is available on DVCs 3 and 4, and is controlled by an LSD control panel located on the DVC. With this subsystem, command and group viewing of a selected DVC is possible.

DISPLAY GROUP CONFIGURATION.— The display group is composed of five DVCs and two LSDs and their associated equipment. There are three display chains in the display group. Display chain 1 has two DVCs, located in the Analysis area (console #1) and the Brief/Debrief room (console #3). Display chain 2 has two DVCs, located in the Command/Evaluator area (console #2) and the Command/OPCON area (console #4). Display chain 3 has one DVC (console #5) which is used as the ASWCCCS high level terminal (HLT) console.

DVC FUNCTIONS AND CAPABILITIES.—The DVC provides the operator with a means to accomplish the following:

1. Access, update, and use the ASWOC data base

2. Display desired portions of the data base on the situation and tableau displays

3. Initiate the generation of hard copies of a desired portion of the ASWOC data base on the high speed printer and/or the X-Y plotter

4. Generate new data for entry into the ASWOC data base

5. Format and edit messages

The DVC provides the operator with a means to perform specific task assignments through use of operational software programs such as:

1. Data presentation

2. Data reduction

3. Mission replay

4. Sonic analysis

5. Data link operations

6. Interactions

ASWOC Communications Subsystem

The Communications Subsystem provides the ASWOC with a means of communicating both by secure data networks and secure voice networks. This assures two methods of communicating with subordinate aircraft and afloat units and with the Force Commander at the FCC. The following paragraphs will discuss the portion of the Communications Subsystem which deals with data communications to and from the ASWOC.

The Communications Subsystem consists of the following equipment:

1. Terminal Communications Interface
2. Teletype Interface
3. Data Link Interface
4. Data Terminal Multiplexer

The above units provide a means of communicating via Link 11, AUTODIN landlines, and teletype to and from other units external to the ASWOC.

TERMINAL COMMUNICATIONS INTERFACE.—The terminal communications interface is commonly referred to as the TCI. The TCI system (fig. 2-4) serves to interface the CP-901 central computer with serial data landlines using modified Autodin Mode I line discipline in full duplex. The TCI system is composed of the following equipment:

1. Terminal Communications Interface Federal Pacific Electric Model 21810
2. Data Network Controller Model 7500
3. Manually Programmable Diagnostic Terminal Compunetics Model 7501
4. Power Supply Compunetics Model 5696

The TCI continuously receives serial data from the landlines in the form of an 8-bit ASCII code (seven data bits plus a parity bit). The TCI converts these serial characters to a parallel format, removes the parity bit, holds them in a buffer and forwards them to the CP-901, four 7-bit characters at a time.

The TCI functions as a parallel to serial converter in the transmit mode of operation between the CP-901 and the landlines. The CP-901 sends data to the TCI four 7-bit characters at a time. The TCI converts the parallel data to 7-bit serial ASCII code, adds a parity bit, and transmits the 8-bit code over the landline.

TELETYPE INTERFACE COMPUNETICS MODEL 5662.—The Teletype Interface Compunetics Model 5662 (fig. 2-4) is a serial-to-parallel/parallel-to-serial converter and interface between the CP-901 computer and any standard tty circuit. The tty interface converts parallel 30-bit computer words into serial data for the teletype in the send mode. In the receive mode, the tty interface converts serial teletype data into a parallel 30-bit word for input into the CP-901 computer. The tty interface allows formatted messages to be transmitted and received by the ASWOC using conventional teletype circuits.

DATA LINK INTERFACE COMPUNETICS MODEL 67B0.—The Data Link Interface Compunetics Model 67B0 (fig. 2-4) is an interface unit between the CP-901 and the AN/USQ-76 Data Link Terminal Set. The data link interface provides the DVC operator with a means of controlling the two-way data flow between the ASWOC and mission aircraft or afloat forces. Additional information on Link 11 may be found in *Data Systems Technician 3 & 2*, Vol. 2, NAVEDTRA 10201 (Series).

DATA TERMINAL MULTIPLEXER.— Data terminal equipment (fig. 2-4) is used by the peripheral manager and at other stations. The peripheral manager station provides the capability of system initialization and recovery and the performance of specific operational tasks. The message stations provide the capability of displaying incoming RAINFORM message traffic, or construction of RAINFORM messages for transmission and provide the operator with a capability to generate a Preflight Data Insertion Program (PDIP) tape for P-3C and S-3A flights. The multiplexer converter permits communications between the CP-901 computer and the three data terminals. No data bit conversion is necessary. The peripheral manager (PM STATION) and the two message stations are identical in hardware configuration. They differ only in the functions they perform and the legends in the auxiliary switches.

Each terminal contains a display control section which generates all the timing and control signals for the display and keyboard unit. It also contains an interface unit and a memory. Data can be written into the memory from the keyboard of the display/keyboard unit or remotely from the computer via the interface unit.

ASWOC SYSTEM SUMMARY

Each component subsystem of the ASWOC provides a unique function toward the accomplishment of the operational goals of the system. The ADP Subsystem performs the following functions for the system:

1. Data manipulation
2. Data storage
3. Control and routing of data between various subsystems and ADP system components

The Display Subsystem provides a means of presenting data which has been processed and stored by the ADP Subsystem. The data comes from other subsystems, such as the Analysis Subsystem or the Communications Subsystem. Local data may also be entered by means of the Display Subsystem to update or modify the ASWOC data base.

The Communications Subsystem, under control of the ADP Subsystem, provides paths for data either coming into or leaving the ASWOC. The Communications Subsystem is a prime source of external data from other component systems of the NCCS.

The Analysis Subsystem provides a means of analyzing sensor data furnished by patrol aircraft. The Analysis Subsystem plays a large role in determining and interpreting sensor data.

FORCE HIGH LEVEL TERMINAL

The Force High Level Terminal (FHLT) has all the ASWOC/HLT capabilities except aircraft mission support and reduction. It also has the following capabilities:

1. Expanded local data base
2. Enhanced geographic display

3. ASWCCCS data base management
4. ASWCCCS monitor
5. Degraded mode capability
6. Report generation

Much of the same type of equipment used at the ASWOC is also used at an FHLT. The FHLT also has some equipment, not found in an ASWOC, needed to handle its additional role. The FHLT is an ADP system with supporting peripheral display, data storage, hardcopy, and communications subsystems. Each FHLT has an ADP Subsystem, a Display Subsystem, and a Communications Subsystem. For ease of explanation, the FHLT equipment will be grouped according to subsystem.

FHLT FUNCTIONS AND SUBSYSTEMS

The Force High Level Terminal (FHLT) (fig. 2-5, a foldout at the end of this chapter) portion of the NCCS is a display augmented computer system configured around an AN/UYK-7 three-bay computer. It is designed to give the ASW Force Commander the ADP tools necessary to integrate, correlate, analyze, control, and disseminate pertinent ASW data. The extensive man-machine interface capabilities are provided via direct view consoles (DVCs) alphanumeic crt terminals, high-speed printers, an online X-Y plotter, a manual plot entry (MPE) device, an online teletype, and DVC driven large group displays (LGDs). The FHLT is the hub of the ASW network in each geographic area (Atlantic, Mediterrranean, Eastern Pacific, and Western Pacific).

FHLT Automatic Data Processing (ADP) Subsystem

The ADP Subsystem is the center of the FHLT equipment suite. All data to and from the FHLT is stored, processed, and converted to usable formats in the ADP Subsystem. The ADP Subsystem consists of the central computer and its associated peripheral equipment. The FHLT ADP Subsystem consists of the following equipment in the quantities indicated:

1. AN/UYK-7(V) Computer Set (3 bays)

2. Magnetic Tape Controller Compunetics Model 28112 (1)
3. Magnetic Tape Transport Kennedy Model 9100 (3)
4. Disk Controller CDC Model 560533A (2)
5. Disk Storage Unit CDC Model 560718A (4)
6. X-Y Plotter Zeta Model 36005 (1)
7. Manual Plot Entry Compunetics Model 28140 (1)
8. High Speed Printer Data Products Model 2290 (2)
9. High Speed Printer Data Products Model 2230 (1)
10. Teletypewriter AN/UGC-48 (1)
11. Teletype Interface Compunetics Model 28150 (1)
12. Plotter Interface Compunetics Model 28122 (1)
13. High Speed Printer Interface Compunetics Model 1721020 (1)
14. Manual Plot Entry Interface Compunetics Model 28142 (1)

As mentioned previously, much of the equipment used in the FHLT is similar to that used in the ASWOC. The model number may be different, but the function of the X-Y plotter is the same at both sites. Figure 2-5 is a simplified block diagram of the FHLT. There are only a few additional equipment present at the FHLT, which perform functions or provide capabilities that the ASWOC does not have.

FHLT DIGITAL COMPUTER SET AN/UYK-7(V).—The AN/UYK-7(V) general purpose digital computer set (fig. 2-5) is the host computer at the FHLT. The FHLT configuration consists of a three-bay, dual CPU, dual IOC installation. The triple-bay AN/UYK-7(V) contains nine 16K CMUs which provides 147K of memory. The third bay provides an additional storage capacity of 49K. Use of the triple-bay AN/UYK-7(V) computer in the FHLT eliminates the need for the signal data buffers (SDBs) used with the ASWOC CP-901 computer (fig. 2-4). The AN/UYK-7(V) computer provides more data storage, computing power, and I/O channels for the FHLT ADP Subsystem. For additional information on the Digital Computer Set AN/UYK-7(V), refer to *Data Systems Technician 1 & C*, Vol. 1, NAVEDTRA 10203 (Series).

FHLT DISK CONTROLLERS AND DISK DRIVES.—The disk controllers and disk drive units (fig. 2-5) used in the FHLT are the same as those used at an ASWOC site (fig. 2-4). The only difference is that the FHLT configuration has four disk drive units. This feature provides the FHLT with four times the random access storage capacity of an ASWOC site.

FHLT HIGH SPEED PRINTERS & INTERFACE.—The FHLT high speed printers (HSPs) and printer interface (fig. 2-5) provide twice the capacity for producing hard copy material as the ASWOC ADP Subsystem. The FHLT contains a large Data Products Model 2230 HSP, and two smaller Data Products HSPs.

FHLT INTERFACE EQUIPMENT.—The FHLT has interface equipment (fig. 2-5) similar to the interface equipment found at ASWOC sites. The teletype (tty), MPE, and X-Y plotter interfaces all adapt the data outputs from or inputs to these devices (tty, MPE, and X-Y plotter) to the line logic used by the AN/UYK-7(V) computer. The interface units allow off-the-shelf commercial equipment to be used with military computers.

FHLT Display Subsystem

The FHLT Display Subsystem is comprised of the direct view consoles (DVCs), large group displays (LGDs), and data terminal displays (DTDs). These units provide visual displays of situations, data, and incoming messages.

The FHLT Display Subsystem is composed of the following equipment in the quantities indicated:

1. Direct View Console Raytheon Model OJ-448/FYQ (4)
2. Large Group Display Aydin Model 8063C (2)
3. Data Terminal Display UNIVAC Model U-2000 (5)
4. Liquid Crystal Light Valve Projector Hughes Model HPD 2000 (1)

The above-listed equipment are the major components of the Display Subsystem. There are also keysets, power supplies, and other off-the-shelf units used by the Display Subsystem.

FHLT DIRECT VIEW CONSOLE.—The Direct View Console (DVC) Raytheon Model OJ-448/FYQ (fig. 2-5) used at the FHLT is an improved multicolor capable DVC; rather than the monochromic unit used at ASWOC sites. The function and capabilities of the FHLT DVCs are similar to the units used at the ASWOC sites, except the FHLT DVCs are multicolor. Only four DVCs are used at the FHLT.

The FHLT DVCs contain a display generator which eliminates the need for the display equipment racks used in the ASWOC Display Subsystem.

FHLT LARGE GROUP DISPLAY/LIQUID CRYSTAL LIGHT VALVE PROJECTOR.— The large group display/liquid crystal light valve projector (LGD/LCLV) (fig. 2-5) projects the data presented on either the tactical display or tableau display of a selected DVC onto wall screens for training, briefing, critiquing, and command-associated functions. The display on the LGD/LCLV is controlled by the DVC operator through a video switcher. The operator of any DVC can select the tabular or tactical display and project it on one of the screens. The LGD can project either a tabular display or a tactical display. The LCLV has the same capability. The FHLT computer has neither interface with the LGD/LCLVs, nor control over their use.

FHLT DATA TERMINAL DISPLAY.—The data terminal displays (DTDs) (fig. 2-5) are UNIVAC U-2000 crt displays and keyboards used for equipment control and as message stations. The Peripheral Manager (PM) station provides a means for managing system peripheral performance and recovery and initiating standard ADP operations. The three message station DTDs provide a secondary capability of generating, reviewing, and modifying standard Navy message traffic processed by the FHLT system.

FHLT Communications Subsystem

The Communications Subsystem provides a method of transferring secure data between the FHLT and other units of the NCCS. (Refer to figure 2-2.) The FHLT has the capability of communicating with all ASWOC/HLTs in the geographic area at once.

The Communications Subsystem consists of the following equipment in the quantities indicated:

1. Programmable Terminal Communications Interface Compunetics Model 22300 (1)

2. Computer Communication Line Monitor Compunetics Model 22400 (1)

These units control the secure data communications to and from the FHLT subsystems.

PROGRAMMABLE TERMINAL COMMUNICATIONS INTERFACE.—The Programmable Terminal Communications Interface Compunetics Model 22300 (fig. 2-5) is commonly referred to as the PTCI. The PTCI provides an interface between the FHLT AN/UYK-7(V) computer and one to eight full duplex ASWCCCS communications lines. The PTCI can be expanded to handle up to 16 communications lines. In the case of a failure of the CLI (communications line interface), all of the data circuits to the ASWOC/HLTs will be routed to the FHLT through the PTCI. The PTCI is an automated unattended system.

COMPUTER COMMUNICATIONS LINE MONITOR.—The Computer Communications Line Monitor Compunetics Model 22400 (fig. 2-5) is commonly referred to as the CCLM. The CCLM is mounted in an equipment rack near the PTCI and provides a means of checking data out of the PTCI. The CCLM monitors the output of the PTCI at its modems and feeds the data back to the FHLT computer. The data provides the FHLT computer with a means of checking PTCI operation.

Communications Line Interface

The CLI serves as the hub of each of the four ASWCCCS secure data networks. Configured around a Honeywell Information System (HIS) 716 minicomputer, the CLI is the automatic store-and-forward, message-switching, control and routing station which provides the pathway for message communications between and among the FHLT, ASWOCs, and ASWCCCS Central Site.

Within each of the four ASWCCCS secure data networks, each node terminates on a different channel of the CLI. The Atlantic and the Europe/Mediterranean CLIs are interconnected via a separate channel. The same is true for the Eastern and Western Pacific CLIs. Each CLI channel can be independently monitored, controlled, opened, and closed by the CLI service station teletype (tty) operator.

FHLT SYSTEM SUMMARY

The relationship and functions of the FHLT Subsystems are similar to those of the ASWOC. The hardware functions are identical in many cases. The Subsystem roles are the same in both the ASWOC and the FHLT.

CARRIER-ANTISUBMARINE WARFARE MODULE

The Carrier-Antisubmarine Warfare Module (CV-ASWM) is the seagoing equivalent of the ASWOC. The CV-ASWM gives the fleet an up-to-the-second high data rate ASW capacity which is compatible with the most advanced airborne weapon systems presently in use or envisioned for the future. It has a fast and flexible display capability, which makes possible rapid target detection, classification, evaluation, and decision making. This means that the coordinated ASW force, when supported by the CV-ASWM, are more effective when hunting or tracking submarines than they previously were. The CV-ASWM is the carrier ASW nerve center of the future.

CV-ASWM OPERATIONAL CONCEPT

The basic function of the CV-ASWM is to provide an advanced mission brief/debrief capability as an aid to the newest carrier ASW airborne systems. It also provides real-time and delayed-time data processing from airborne ASW platforms. The CV-ASWM enhances the capabilities of the flight crews by quickly processing and displaying critical sensor input data, so that the ASW team can make fast and accurate evaluations and decisions.

The major aircraft associated with the CV-ASWM are the SH-3, S-3A, P-3C, and the Light Airborne Multipurpose System (LAMPS) helo. During the mission, each aircraft transmits data to the carrier. This is in the form of an acoustic link from the SH-3 and LAMPS helos, voice link (uhf, secure uhf, and hf) from all aircraft, and digital data link from the S-3A and the P-3C. Selected digital data is transmitted via Link 11 to the CIC (combat information center) and relayed through the NTDS computers to the computers in the CV-ASWM.

During the ASW mission, the S-3A aircraft's magnetic tape recorders store acoustic data and mission profile data. When the S-3A returns to the carrier, the tape-stored data is brought to the CV-ASWM and processed. The processed data is then displayed for post-engagement analysis, briefing/debriefing flight crews, and preparing preflight tapes for the S-3A. The preflight tapes contain mission related data such as contact information, communications frequencies, and environmental conditions which is entered into the aircrafts computer prior to launch. Tactical and intelligence data derived from mission aircraft is also exchanged with NTDS, CVIC, and the TFCC.

The locating of a submarine is a group effort. Inputs concerning the whereabouts of a submarine can be reported to the CV-ASWM from outlying surface units that make sonar contact, from an aircraft that visually spots a submarine, and by analyzing the data from sonobuoys dropped into the water by an ASW aircraft. The CV-ASWM evaluates this data and recommends a course of action.

The CV-ASWM consists of three distinct subsystems. Each performs a portion of the overall CV-ASWM task of analyzing, evaluating, displaying, and communicating information. The three subsystems of the CV-ASWM are:

1. The Automatic Data Processing Subsystem
2. The Display Subsystem
3. The Communications Subsystem

CV-ASWM Automatic Data Processing (ADP) Subsystem

The CV-ASWM Automatic Data Processing Subsystem stores, reduces, converts, and routes

data to the various displays and peripherals of the CV-ASWM. The ADP system is composed of the following equipment in the quantities indicated:

1. Digital Computer AN/UYK-7(V) (1)
2. Digital Computer AN/UYK-20(V) (1)
3. Teletypewriter Set OJ-212(V)/UYK (1)
4. Magnetic Disk Recorder/Reproducer AN/UYH-3(V) (1)
5. Digital Magnetic Tape Controller (1)
6. Digital Magnetic Tape Unit RD-348/ASH (2)
7. High Speed Printer RD-280/UYK (1)
8. Magnetic Tape Unit RD-358(V)/UYK (1)
9. I/O Console OA-7984/UYK(V) (1)
10. Fast/Slow Adapter (1)

CV-ASWM DIGITAL COMPUTER AN/UYK-7(V).—The CV-ASWM Digital Computer AN/UYK-7(V) (fig. 2-6, a foldout at the end of this chapter) is the center of the CV-ASWM system. It is responsible for the control of all data flow within the CV-ASWM. It also accomplishes most of the tactical computations used in the system. The AN/UYK-7(V) configuration used with the CV-ASWM is a two-bay installation. One bay consists of a single CPU, single IOC, single IOA, triple CMU configuration. The other bay is an expanded memory bay containing three Core Memory Units (CMUs). Additional information on the AN/UYK-7(V) computer set may be found in *Data Systems Technician 1 & C*, Vol. 1, NAVEDTRA 10203 (Series).

CV-ASWM DIGITAL COMPUTER AN/UYK-20(V).—The Digital Computer AN/UYK-20(V) (fig. 2-6) is used for the buffer operations between the AN/UYK-7(V) computer and the Hughes Display Subsystem. It also is directly responsible for controlling the audio switching matrix in the Communications Subsystem.

The AN/UYK-20(V) is a 16-bit microprogram controlled computer set. It has a memory capacity of 65K data words and can control up to 16 full-duplex I/O channels. Available I/O channel interface levels are NTDS SLOW, NTDS FAST, ANEW in parallel data. Serial data channels are available for up to four channels and are available in NTDS serial, MIL-STD-188C, EIA Standard RS-232C and VACALES (Variable Character

Length Synchronous). For additional details refer to *AN/UYK-20(V) Data Processing Set*, Vol. 1, NAVELEX 0967-LP-598-1010.

TELETYPEWRITER SET OJ-212(V)/UYK.—The Teletypewriter Set OJ-212(V)/UYK is commonly referred to as the OJ-212. The OJ-212 (fig. 2-6) is a computer interfaced, 100 words-per-minute teletype machine. It is used to provide an interface into the communications net for generation and reception of message traffic. For additional information on the OJ-212(V)/UYK teletypewriter set, refer to *Data Systems Technician 3 & 2*, Vol. 1, NAVEDTRA 10201 (Series).

MAGNETIC DISK RECORDER/REPRODUCER AN/UYH-3(V).—The Magnetic Disk Recorder/Reproducer AN/UYH-3(V) (fig. 2-6) is commonly referred to as the UYH-3 disk file. The UYH-3 disk file is a high density random access magnetic disk storage unit capable of storing 642 megabits of data.

The UYH-3 consists of a disk drive control unit and two RD-448(V)/U disk drive units. Disk packs used in the UYH-3 contain five 14-inch disks which have eight writing surfaces. Only five writing surfaces are used for data.

The UYH-3 stores all of the nonresident data used by the AN/UYK-7 computer for a tabular display. The TAC/TAB console operator can call up this data for a particular mission or sortie. The access time of the disk file gives the operator almost an immediate response to a request. For additional information on disk operation, refer to *Data Systems Technician 3 & 2*, Vol. 2, NAVEDTRA 10201 (Series).

CV-ASWM DIGITAL MAGNETIC TAPE CONTROLLER/UNIT RD-348/ASH.—The Digital Magnetic Tape Controller/Unit (DMTC/DMTU) RD-348/ASH (fig. 2-6) is responsible for writing preflight data onto the S-3A aircraft cassette tape for its inflight data. After the aircraft returns to the ship, the data recorded onto the cassette during the S-3A flight is read and transmitted to the CV-ASWM computers for evaluation and dissemination to ASW operations.

The DMTC/DMTU consists of three units: the digital magnetic tape controller and two digital

magnetic tape units. The controller converts the data from the S-3A cassette tape into a format usable by the AN/UYK-7(V) computer. It also converts computer data to a format which can be entered into the S-3A computer. The DMTU records and plays back preflight and flight data from the S-3A aircraft.

CV-ASWM HIGH SPEED PRINTER RO-280/UYK.

—The High Speed Printer (HSP) RO-280/UYK (fig. 2-6) is used to produce the mission data in a hard copy form. This allows the data to be analyzed at a later time without tying up an entire system while a mission is replayed. The RO-280 HSP is capable of producing copy at a rate of 600 lines per minute. For additional information on high-speed printers, refer to *Data Systems Technician 3 & 2*, Vol. 2, NAVEDTRA 10201 (Series).

CV-ASWM MAGNETIC TAPE UNIT RD-358(V)/UYK.

—The Magnetic Tape Unit (MTU) RD-358(V)/UYK (fig. 2-6) is a UNIVAC Model 1840M autoloading tape unit that is responsible for the initial loading of the CV-ASWM computer programs. During normal operation one tape drive is used for the system program tape and the other drive is used for a system save tape. All information in the system that might be used at a later date can be saved by loading the data onto the system save tape.

CV-ASWM I/O CONSOLE OA-7984/UYK(V).

—The I/O Console OA-7984/UYK(V) (fig. 2-6) is commonly referred to as the I/OC. The I/OC is a UNIVAC Model 1532 I/O Console. It is the manual interface device between the operator and the program. It allows the user to enter parameters and other data necessary to initialize the CV-ASWM operational program.

The I/OC consists of a teletype keyboard and a paper tape reader as input devices. A tty page printer and a high-speed punch provide output capabilities. An interface and timing unit converts serial tty data to a parallel format for transmission to the computer. Parallel computer data is converted to serial tty data for use by the tty page printer. The interface/timing unit provides all timing signals for internal operation and external communication with the CV-ASWM computer.

CV-ASWM FAST/SLOW ADAPTER.

—The Fast/Slow Adapter (fig. 2-6) converts the AN/UYK-7(V) FAST I/O logic levels to NTDS SLOW logic levels. This allows the CV-ASWM to transfer data to NTDS via bidirectional intercomputer link.

The fast/slow adapter contains input and output buffers and timing circuits to provide the logic levels and timing required for the respective computers. The fast/slow adapter also converts logic levels between the OJ-212 and the AN/UYK-7(V). This allows the generation of tty tapes, by program control, for transmission by the ship's communications facility.

CV-ASWM Display Subsystem

The Data Display Subsystem in the CV-ASWM is the Tactical/Tabular Display System AN/SSQ-78(V). This display system is responsible for presenting a tactical ASW picture of any specified operational area within a range of 1024 miles. The Display Subsystem is composed of the following equipment in the quantities indicated:

1. TAC/TAB Display Generator Unit AN/SSQ-78(V) (1)

2. Data Display Console OJ-374/SSQ-78(V) (5)

3. Data Display Console OJ-375/SSQ-78(V) (1)

4. Digital Television Projection Unit IP-1231/SSQ (1)

5. Hard Copy Unit Versatech Model 1100 (2)

TAC/TAB DISPLAY GENERATOR UNIT AN/SSQ-78(V).

—The TAC/TAB Display Generator Unit AN/SSQ-78(V) (fig. 2-6) is commonly referred to as the DGU. The DGU provides the timing, symbol forming voltages, and multiplexing functions of the Display Subsystem. Data transferred between the CV-ASWM computer and the data display consoles and hard copy units is via the DGU. The DGU allows one computer I/O channel to interface with six consoles and two hard copy units.

The DGU also provides signal timing and symbol forming voltages for the five tactical/tabular display consoles.

DATA DISPLAY CONSOLE OJ-374/SSQ-78(V).—The Data Display Console OJ-374/SSQ-78(V) (fig. 2-6) is the main man-machine interface unit of the Display Subsystem. It contains two crt's which provide both a tabular data display and a tactical situation display for the operator. Their functions are similar to the DVCs mentioned previously in this chapter. The presentation an operator sees is a regular television picture consisting of 1024 lines of interlaced video. The console operator of the Brief/Debrief Console #1 has the additional capability of displaying either a tactical or tabular picture on a large screen display.

DATA DISPLAY CONSOLE OJ-375/SSQ-78(V).—The Data Display Console OJ-375/SSQ-78(V) (fig. 2-6) is a single crt console used for the display of tabular data. It is referred to as the ADP operator console and is located in the same spaces with the data processing equipment. The ADP operator can analyze data and cause a hard copy of the tactical or tabular data to be printed out on the hard copy unit for future use by the CV-ASWM.

DIGITAL TELEVISION PROJECTION UNIT IP-1231/SSQ.—The Digital Television Projection Unit IP-1231/SSQ is commonly referred to as the DTVPU. The DTVPU provides the same brief/debrief capabilities to the CV-ASWM as is provided to the ASWOC and FHLT by their respective LSDs and LGDs. A tactical or tabular display of interest to the assembled personnel can be selected by the operator of Brief/Debrief Console #1 for display by means of the DTVPU on a large screen.

HARD COPY UNIT VERSATECH MODEL 1100.—The Versatech Model 1100 hard copy unit (fig. 2-6) is commonly referred to as the HCU. The HCU is a medium speed printer which provides the CV-ASWM with a hard copy of tactical or tabular data for use at a later date. The HCU performs the same function at the CV-ASWM as the HSPs at the ASWOCs and FHLTs.

CV-ASWM Communications Subsystem

The CV-ASWM Communications Subsystem provides for audio communications between the various console operators and allows the console operator to use ship's external communication equipment. The CV-ASWM Communications Subsystem consists of the Audio Switching Matrix SA-2033/SYQ.

AUDIO SWITCHING MATRIX SA-2033/SYQ.—The Audio Switching Matrix SA-2033/SYQ (fig. 2-6) is commonly referred to as the ASM. The ASM operates under the control of the AN/UYK-20(V) computer. When a switch is depressed in the COMMUNICATIONS section of a display console, a digital code is sent to the AN/UYK-20(V). The AN/UYK-20(V) converts the code into crosspoint data and sends the two crosspoints to the ASM. The audio switching matrix then selects the circuit, as directed by the AN/UYK-20(V) computer, and communications between the console operator and another console or radio is established.

NCCS SUMMARY

There are striking similarities and differences in the three NCCS subsystems that we have discussed in this chapter. The task of the ASWOC and the CV-ASWM are very similar. The equipment located at ASWOCs and FHLTs is the same in many cases.

As a DS1 or DSC your prime job is overseeing the maintenance of these systems. The maintenance techniques required to maintain each of these systems do not vary greatly from the techniques required to maintain a shipboard NTDS system or a TRIDENT submarine Command and Control System. Although the equipment nomenclature may change from site-to-site or system-to-system, the same sound, common sense maintenance practices are required universally. As a DS1 or DSC, you must know your system thoroughly, keep your technical documentation and knowledge up-to-date, and practice sound maintenance policies. Above all else, you must ENSURE the personnel you supervise do the same thing.
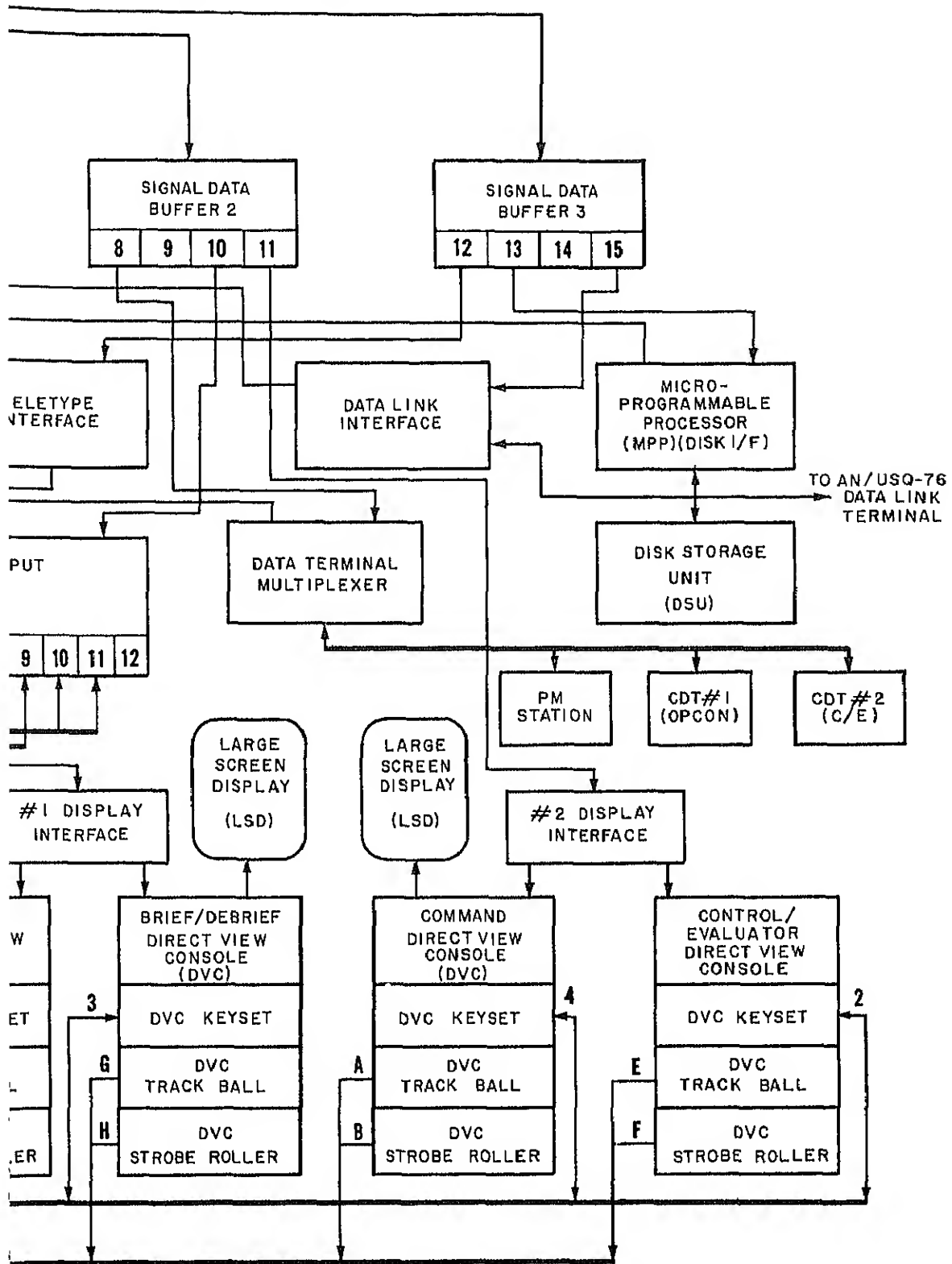
GLOSSARY OF ABBREVIATIONS

ABBREVIATION	DEFINITION
ADP	Automatic Data Processing
ADS	Automatic Digital Switch
ASM	Audio Switching Matrix
ASV	ASWCCCS Secure Voice
ASWCCCS	Antisubmarine Warfare Center Command & Control System
ASWIXS	Antisubmarine Warfare Information Exchange System
ASWOC	Antisubmarine Warfare Operations Center
AUTODIN	Automatic Digital Information Network
B/DB	Brief/Debrief
BFCF	Blue Force Characteristic File
C^2	Command and Control
CCLM	Computer Communications Line Monitor
CIC	Combat Information Center
CLI	Communications line interface
CPU	Central processing unit
CS	Central Site
CV-ASWM	Carrier-Antisubmarine Warfare Module
DCU	Disk control unit
DER	Display electronics rack
DGU	Display generator unit
DIM/DOM	Digital input multiplexer/digital output multiplexer
DMTC	Digital magnetic tape controller

ABBREVIATION	DEFINITION
DMTI	Digital magnetic tape interface
DMTU	Digital magnetic tape unit
DPF	Data processing equipment
DSU	Disk storage unit
DTD	Data terminal display
DTVPU	Digital television projection unit
DVC	Direct view console
FCC	Fleet Command Centers
FHLT	Force High Level Terminal
FLTSATCOM	Fleet Satellite Communications
FOSIC	Fleet Ocean Surveillance Information Center
FOSIF	Fleet Ocean Surveillance Information Facility
FTA	Fast Time Analysis System
GADS	Graphic Analysis and Display System
HCU	Hard copy unit
HLT	High-level terminal
HSP	High speed printer
ICS	Integrated Command System
IID	Integrated information display
LAMPS	Light Airborne Multipurpose System
LCLV	Liquid Crystal Light Valve
LDMX	Local Digital Message Exchange
LGD	Large group displays
LLT	Low-level terminal

ABBREVIATION	DEFINITION
LSD	Large screen display
MIP	Message input processor
MMP	Mass memory and microprogrammable processor
MPE	Manual plot entry
MPP	Microprogrammable processor
MTT	Magnetic tape transport
MTTI	Magnetic tape transport interface unit
MTU	Magnetic tape unit
NAVMACS	Navy Modular Automated Communications System
NCC	Navy Command Center
NCCS	Navy Command and Control System
NCSC	Navy Command Support Center (CNO)
NOSIC	Naval Ocean Surveillance Information Center
NRS	Navy Reporting Structure
NSOF	Naval Status of Forces
NTS	Naval Telecommunications System
NWSS	Navy WWMCCS Software Standardization
OPCON	Operations Control Center
OSIS	Ocean Surveillance Information System
OTC	Officer in Tactical Command
OTH-T	Over the Horizon Targeting
PM	Peripheral Manager
PTCI	Programmable Terminal Control Interface
S/D	Synchro-to-digital

ABBREVIATION	DEFINITION
SDB	Signal data buffer
SOSUS	Sound and Surveillance System
SSES	Ship's Signal Exploitation Space
SSIXS	Subsurface Information Exchange System
STT	Shore Targeting Terminal
SUBOPAUTH	Submarine Operations Authority
TAC/TAB	Tactical/tabular
TACCO	Tactical Control Officer
TCI	Terminal Communications Interface
TFCC	Tactical Flag Command Center
UNITRACK	Unit Tracking
VIP	Visual information processor
WWMCCS	World Wide Military Command & Control System

```
                  ┌─────────────────┐        ┌─────────────────┐
                  │  SIGNAL DATA    │        │  SIGNAL DATA    │
                  │   BUFFER 2      │        │   BUFFER 3      │
                  ├────┬───┬────┬───┤        ├────┬────┬────┬──┤
                  │ 8  │ 9 │ 10 │11 │        │ 12 │ 13 │ 14 │15│
                  └────┴───┴────┴───┘        └────┴────┴────┴──┘
```

SIGNAL DATA BUFFER 2

8 9 10 11

SIGNAL DATA BUFFER 3

12 13 14 15

ELETYPE NTERFACE

DATA LINK INTERFACE

MICRO-PROGRAMMABLE PROCESSOR (MPP)(DISK I/F)

TO AN/USQ-76 DATA LINK TERMINAL

PUT

DATA TERMINAL MULTIPLEXER

DISK STORAGE UNIT (DSU)

9 10 11 12

PM STATION

CDT#I (OPCON)

CDT#2 (C/E)

#I DISPLAY INTERFACE

LARGE SCREEN DISPLAY (LSD)

LARGE SCREEN DISPLAY (LSD)

#2 DISPLAY INTERFACE

W

BRIEF/DEBRIEF DIRECT VIEW CONSOLE (DVC)

COMMAND DIRECT VIEW CONSOLE (DVC)

CONTROL/ EVALUATOR DIRECT VIEW CONSOLE

ET

3

DVC KEYSET

DVC KEYSET

4

DVC KEYSET

2

L

G

DVC TRACK BALL

A

DVC TRACK BALL

E

DVC TRACK BALL

ER

H

DVC STROBE ROLLER

B

DVC STROBE ROLLER

F

DVC STROBE ROLLER

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ck diagram.

| 14 | 15 | 16 | 17 |

DISK
STORAGE
UNIT
(DSU)

2

DISK
STORAGE
UNIT
(DSU)

4

DISK CONTROLLER
UNIT (DCU)

2

INAL
Y

PROGRAMMABLE TERMINAL
COMMUNICATIONS
INTERFACE (PTCI)

Ch. 1
Ch. 2
Ch. 3
Ch. 4
Ch. 5
Ch. 6
Ch. 7
Ch. 8

TO/FROM
MODEMS

PEED
R (HSP)

IINAL
Y

MPE KEYSET
(DTD)

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HARD
COPY
UNIT
#2
HCU)

OJ-374/SSQ-78(V)
DATA DISPLAY
CONSOLE
TACCO#1

C

ABEF

HARD
COPY
UNIT
#1
(HCU)

GH

H

OJ-374/SSQ-78(V)
DATA DISPLAY
CONSOLE
TACCO#2

ABEF

C

LEGEND

A TACTICAL VIDEO
B TABULAR VIDEO
C ICS AUDIO
D DIGITAL DATA
E MPE DATA
F TKB DATA
G HCU TABULAR DATA
H HCU TACTICAL DATA
I SERIAL tty DATA
J REMOTE CONTROL

OJ-374/SSQ-78(V)
DATA DISPLAY
CONSOLE
WATCH OFFICER

ABEF

C

OJ-374/SSQ-78(V)
DATA DISPLAY
CONSOLE
BRIEF/DEBRIEF
#1

ABEF

C

ABJ

IP-1231/SSQ
DIGITAL
TELEVISION
PROJECTION
UNIT (DTVPU)

C

OJ-374/SSQ-78(V)
DATA DISPLAY
CONSOLE
BRIEF/DEBRIEF
#2

ABEF

C

IP'S
STEM

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CHAPTER 3

MAINTENANCE PROGRAMMING AND TROUBLESHOOTING

The majority of personnel in the DS rating will obtain some programming experience by the time they are advanced to DS2. For some, this experience may come in the form of machine coding on a main frame computer, or from using one of the several assembler languages or compilers. Others will have used the more familiar high-level languages such as BASIC, COBOL, and FORTRAN. Still others will have gained their experience with Compiler Monitor System-2 CMS-2), the compiler which is used to develop most tactical operational programs and programmed operational and functional appraisals (POFAs). Regardless of your programming background, the technical principles are similar or the same for most computers.

As a DS1 or DSC, you will be required to apply these principles at a system level to solve more difficult, nonroutine problems. You will become more involved in the writing and operation of specialized maintenance programs. These programs will be used to correct specific malfunctions. You will also be expected to modify existing maintenance programs for specialized testing and to write test programs to check a specific function. You will, in all probability, have use an operational program (OP) to locate a hardware problem or even assist in the preliminary debugging in a newly delivered operational program. This chapter will discuss many of the factors to be considered as you become more involved with the broad area of maintenance programming.

MAINTENANCE PROGRAMMING

The word programming can be defined as the field of interest devoted to the art and science of planning the solution of problems and reducing the plan to a set of discrete instructions. These instructions direct the operations of a computing or electronic data processing (EDP) system capable of yielding a solution to the problem. Maintenance programming is defined as the area in the field of programming which consists of the planning and construction of computer programs designed to assist in removing or reducing malfunctions in a computer or peripheral equipment. These computer programs include diagnostic routines, test routines, checking routines, and similar routines. More simply stated, maintenance programming is developing a program or test routine to reveal a defect or problem in a piece of equipment.

PURPOSE OF MAINTENANCE PROGRAMMING

No maintenance or diagnostic program exists which checks 100 percent of the functions of a computer, display device, or peripheral. A maintenance program which tests 98.5 percent of the functions and circuits in a digital device is an extremely complete program. However, testing 100 percent of the circuits and functions of a device under the worst possible conditions is the goal of the ideal maintenance program. From your experience in the DS rating, you know that equipment in an operational environment at sea is subjected to abuse and wear far outside of the original design parameters. Inept or inexperienced operators, unstable primary power, inadequate chilled water or air-conditioning, and vibration and shock are just a few of the causes of electrical and mechanical equipment failures. Some of the failures are of a very subtle nature and do not show up during the operation of a POFA or

diagnostic program. In extreme cases, a POFA or diagnostic program cannot be loaded into the computers. In such cases, the DS may have to devise a program and load it manually in order to troubleshoot the computer or input device. For this reason, we need to know alternate methods of detecting failures in computer systems and other digital equipment. When you are the senior DS and have no one around to ask for help, the ability to develop a special program to detect a malfunction in an equipment or system is of the utmost importance.

As a work group or work center supervisor, you will carry the burden of responsibility for finding solutions when your junior technicians run into problems they cannot solve. The following is an example of a complaint from a DS3.

"I ran I/O POFA between computer Alpha and signal data converter (SDC) No. 2 and the POFA for the SDC. There were no error printouts. When we loaded the operational program, we still couldn't get any data from SDC No. 2."

This is an example of a type of nonroutine problem with which you'll be involved. You are being called upon to apply your technical knowledge and experience at a broader scope and level and on a greater variety of systems and equipment. The question comes to mind, Where do I start? The following sections of this chapter are designed to help organize the steps used in maintenance programming and troubleshooting.

ANALYSIS OF PROBLEM INDICATIONS

The analysis of the problem indications is the first step in locating an intermittent problem or any other problem. The first step in the analysis is determining whether the problem indication is caused by a hardware problem or by a software problem. Let us examine each of the alternatives.

Software Problems

The chances of a system problem resulting from defective system software cannot be entirely eliminated. Programs are tested in-depth before they are delivered to the fleet. Therefore, the chances of the software being defective are small, unless you have a new program or a program that has just been recompiled or patched. Of course, a program as complex as the Naval Tactical Data System (NTDS) Operational Program still could have some bugs. Before you yell software problems, be sure you have all your facts lined up and can show that a software problem exists with reasonable certainty. Don't be guilty of "crying wolf" when in fact the "wolf" exists only in your imagination.

You can start by asking the following questions.

1. Has this program run properly in the past?
2. Has the program run properly with another unit performing the desired function?
3. Has there been a program modification since this function was last performed?

If the answer to question (1) is yes and question (3) is no, chances are that it is not the program. If the answer to question (1) is yes and question (3) is yes, a possibility exists that the program modification (patch) is erroneous or the patch was not installed correctly.

If the answer to question (1) is no (because this is a new program), check the program operation manual to make sure the function you are attempting to perform is being used properly. Often a new program may require different steps to arrive at the same solution produced by a previous version of the program. Make sure no operator error is involved.

If the answer to question (2) is yes, there is a good chance that a hardware problem exists. If, for example, you are trying to write a tape on one tape drive and keep coming up with an error, you should try another tape drive. If the second drive allows you to produce the desired tape, tape drive one must be defective. This simplified example shows how to apply a few logical steps in determining whether you have a software or a hardware problem. Figure 3-1 is a simplified flowchart using the three previous questions to determine if a software problem exists. In addition to answering these three questions, several more decisions must be made to determine the course of action to be taken. When a software problem is found, a Software Trouble Report (STR) is submitted to the cognizant authority. (See procedures for submitting STRs in Chapter 2, Volume 1 of
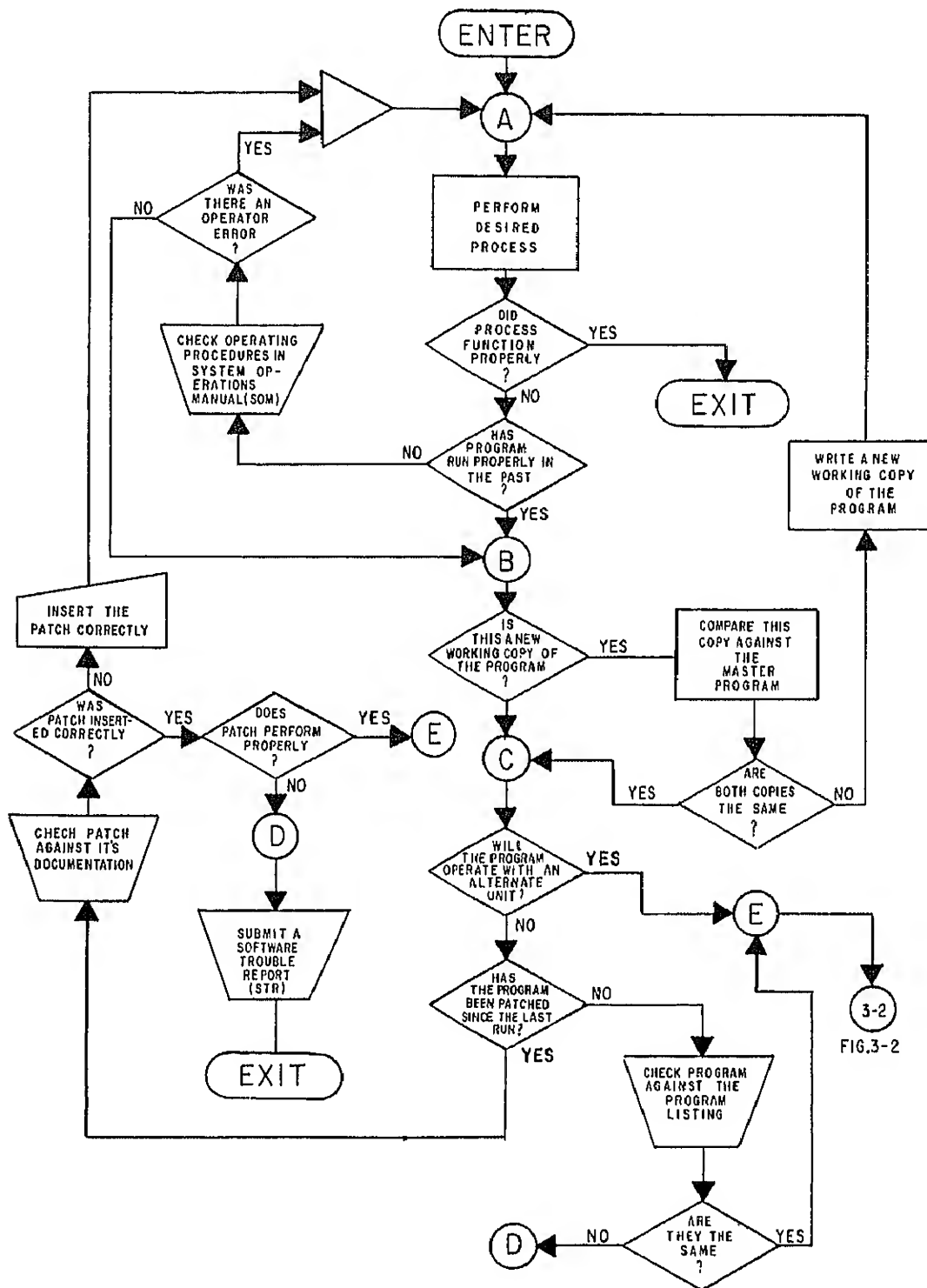
Figure 3-1.—Software troubleshooting flowchart.

Data Systems 1 & C, NAVEDTRA 10203 [Series].) In a number of cases, you or one of your technicians may be able to come up with a fix for a software problem; however, an STR should still be submitted and the recommended fix enclosed with the STR.

Hardware Problems

Hardware problems can be effectively located in much the same way as a software problem. Figure 3-2 (a foldout at the end of this chapter) is a flowchart for use in isolating a hardware problem by using various software. The software can be any available program (e.g., operational and diagnostic).

As we all know, the first indication of a hardware problem is usually produced during the running of an operational program. An operational program can be a tactical program, a data processing program, or a word processing program. If a problem shows up during the running of an operational program, the operator normally notifies a technician. The technician takes over and proceeds to check out the complaint. Often a problem will appear intermittently and infrequently. Sometimes, when the technician checks the operation of the software and hardware together, no indication of a problem is evident. The technician shouldn't be hasty and write the problem off as an operator error. With the hundreds of thousands of logic circuits in today's modern data processing systems, it is often very difficult to get an intermittent problem to reappear.

If a problem gives a solid indication, the technician must analyze it and decide the best method of locating the faulty component. As always, careful analysis of the indications is the first step. What area of the system is producing the problem indication? What equipment are involved in the problem?

AREA TESTING

Area testing is best described as localizing the source of a problem to a subsystem, equipment, or the functional area of an equipment. In many cases, the problem indications will point right to the problem area. In other cases, the problem indications may be the result of bad data fed from an entirely different portion of the system. The DS must, after a careful analysis of the problem indications, decide how to localize the problem or problems. Keep in mind the fact that one trouble indication may mask another one, and a problem in one area can often cause problems in other areas. Once the problem area has been isolated, a method to localize the problem must be determined.

METHOD DETERMINATION

Determining a method of locating a problem depends on the problem indications. If the indications are solid and stay put, the job is greatly simplified. If they are intermittent and show up only occasionally, the job is more difficult.

For the purpose of demonstration, let us look at the case of an AN/UYK-XX computer and an RD-999/UYK magnetic tape unit (MTU). Both of these units are nonexistent and the nomenclature is used only for demonstration purposes. Figure 3-3 is a simplified block diagram. This system is used for compiling programs. Suppose the operators have complained that they cannot do certain jobs which involve sorting of data and reading short data blocks from one reel and writing on another. A DS1 has run the MTU POFA and everything is go. The complex job is attempted again, and it bombs out again. What next? It is obvious that a job like this exercises the tape drives far more strenuously than
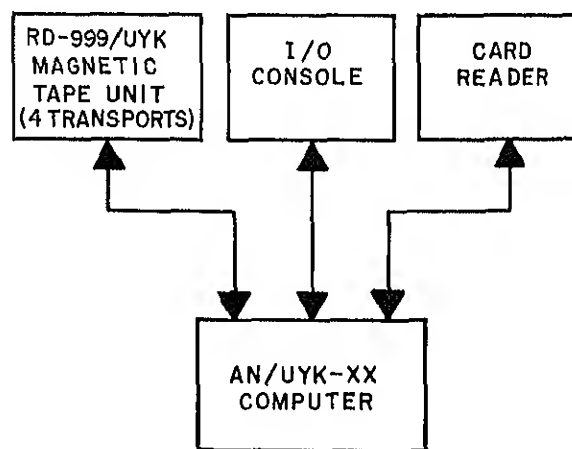
Figure 3-3.—Simplified system block diagram.

the POFA. If the tape unit is capable of operating in marginal conditions, and the POFA still doesn't produce a problem indication, the job program should be used as a test vehicle. In this case, the DS1 adjusted all mechanical and electrical portions of the MTU and cleaned the tape drives. The job program was used to check the work and it ran properly. By careful analysis of the indicators on the front of the MTU, the DS1 had determined that a minor adjustment was needed.

At this stage of your career, most of you will have come across similar problems. The DS1 had experience with the equipment, the knowledge of what the MTU indicators showed when the job "bombed out," and the ability to analyze the problem and determine a method of checking any work that had to be performed. Of course, the DS1 could have written a short program to read and write short blocks of data on first one tape drive and then another one. The conditions under which a read or write error occurred can be duplicated by use of special programs. The technician must decide what vehicles are available to produce the conditions where a failure occurs. Each problem must be analyzed on an individual basis and a choice made as to a test vehicle.

OPERATIONAL PROGRAMS

An operational program normally produces the first indication of a hardware failure. In the typical data processing center, the majority of equipment is used to sort, collate, and list data. Aboard a warship, many systems are involved in handling tactical data used for antisubmarine warfare (ASW) or for other applications in the Combat System. The range of operational programs goes from fairly simple batch sorting data processing to highly complex real-time tactical programs. Many of the more complex programs have built-in system test functions. These can be used to check inputs to the system, operation of various subsystems, and operation of many individual equipments. As a DS, your first priority is to know the purpose, capabilities, and limitations of all the programs and systems used at your site or aboard your ship. Once you have done this, the next step is to learn how best to use these programs in performing the maintenance job and in training your personnel.

ANALYSIS

Analysis of each of the operational programs at your site or aboard your ship will allow you to determine how useful any specific operational program will be in troubleshooting hardware. The majority of tactical data operational programs have numerous built-in test functions as stated previously. They allow testing of a number of the subsystem equipments and provide the DS with a method of testing various units while the program is still operating. Many of these tests provide a comprehensive test of equipment or subsystems. At this time, more programmed equipment functional tests (PEFTs) are being developed for inclusion in the NTDS Operational Program. The function code test for the data display group is an example of a built-in test function in the NTDS Operational Program. It provides the operator or the technician with a quick check of the various general purpose action codes (GPACs) sent from the data display consoles to the NTDS computers. If you desire more information about the ability of the operational program to perform testing on various equipment, check the system operation manuals (SOMs) for the particular program used at your site. The information in the SOM will help you decide how valuable the operational program will be in troubleshooting system problems.

RECOGNITION OF TROUBLE INDICATIONS

As a DS1 or DSC, you will perform a greater role in system troubleshooting. Your job is more like the system analyst in the civilian world. You will be called upon many times to determine if a problem exists or if there is an operator error. You will have to know more about the capabilities of the operational program and the system. This knowledge will enable you to decide where the problem lies—operator, software, or hardware. Only when you obtain a superior knowledge of the system software will you be equipped to make a decision on where the fault is located.

For the sake of brevity in the following pages, the operational program will be referred to as the OP. This reference will be used regardless of the program type (tactical, word processing, or data processing).

USE OF TEST FUNCTIONS IN THE OP

Test functions contained in the OP should be used as often as possible. When your system is down for maintenance, it cannot be properly used for its intended purpose. If a problem is suspected in a piece of equipment and the OP cannot be used to isolate this problem, another plan of action must be tried. Remember, a test function will give you an indication only for the area for which it was designed. If test functions built into the OP do not give you a solid indication, some other means is required.

DIAGNOSTIC PROGRAMS

Diagnostic programs are useful in locating a problem in a piece of equipment once the problem is isolated to that unit. The unit can then be systematically tested and a printout or readout provided to the technician to indicate the problem area. Diagnostic programs can be developed to provide an error code or a direct component location. An error code readout requires searching an error code table to locate the possible bad components. It uses less memory because the component location table is external from the computer. The direct component location readout tells the technician where the problem could be located. This type of program uses more storage space but is faster in producing the location of a suspected failed component.

A diagnostic program doesn't have to be a large bulky program. Any technician with a good understanding of machine coding of a computer and the function of the associated equipment to be tested is capable of writing a short diagnostic program. The diagnostic program can be developed for single function or multifunction testing.

CAPABILITY ANALYSIS

The first thing we have to ask ourselves when deciding whether or not to develop a diagnostic program is: Is it necessary? If, after eliminating every other means of determining the source of a problem, we find it necessary to develop a special diagnostic program, then we have to decide upon the capability of the program. Figure 3-2 shows numerous steps used to find a method of isolating a malfunction to a particular piece of equipment or to a particular area of a piece of equipment. If you look at Decision A, you will read the statement, "Can a special test program, diagnostic or test subroutine be developed to locate the suspected problem?" This statement is reached only after careful analysis of the suspected problem. There may be a time when it is beyond your capability to produce the needed special test program to uncover the suspected problem. In this case, technical assistance from outside sources is available, and it may be a good time to call for help.

Developing a small diagnostic program requires very careful planning just as developing any other type of program. The problem statement, math model, and flowcharts should be layed out at this time to define the problem and determine your goal. A careful study of the logic prints of the equipment in question will give you a better idea of what your program can actually check in the hardware. The diagnostic program you develop should be designed to test specific circuits at the fastest data rate possible. Many times a circuit will operate normally when the data passing through it is at a low rate of speed. When a marginally performing circuit is subjected to a higher data rate, it will frequently fail or produce a more noticeable indication of a malfunction.

FUNCTIONAL TESTING

After determining what the capability of your program should encompass, you need to think about functional testing. You, the technician, have to decide what specific functions your program should test. If a POFA was already run which checked out I/O functions between the computer and your suspect equipment, you don't really have to check it again. If only certain functions in your equipment are not working reliably, then test those functions.

Let's discuss "easter-egging" for a minute. Everyone knows about "easter-egging" or card swapping. This practice can induce more problems than it cures. The first thing a lot of people would think of if they got down to suspecting a few functional circuits is swapping cards. Don't try card swapping unless you have a KNOWN GOOD CARD. Take the time to check the card out in a card tester if one is available, or use a brand new card. This provides no guarantee, but it reduces the chance of causing further problems by inserting a bad card which could load down other circuits and cause them to fail.

After you have decided on what functional tests your program will perform, you should

carefully list the logic circuits that will be tested. This helps to avoid overlooking one or two logic gates which could cause your problem.

Organizing The Testing of Functions

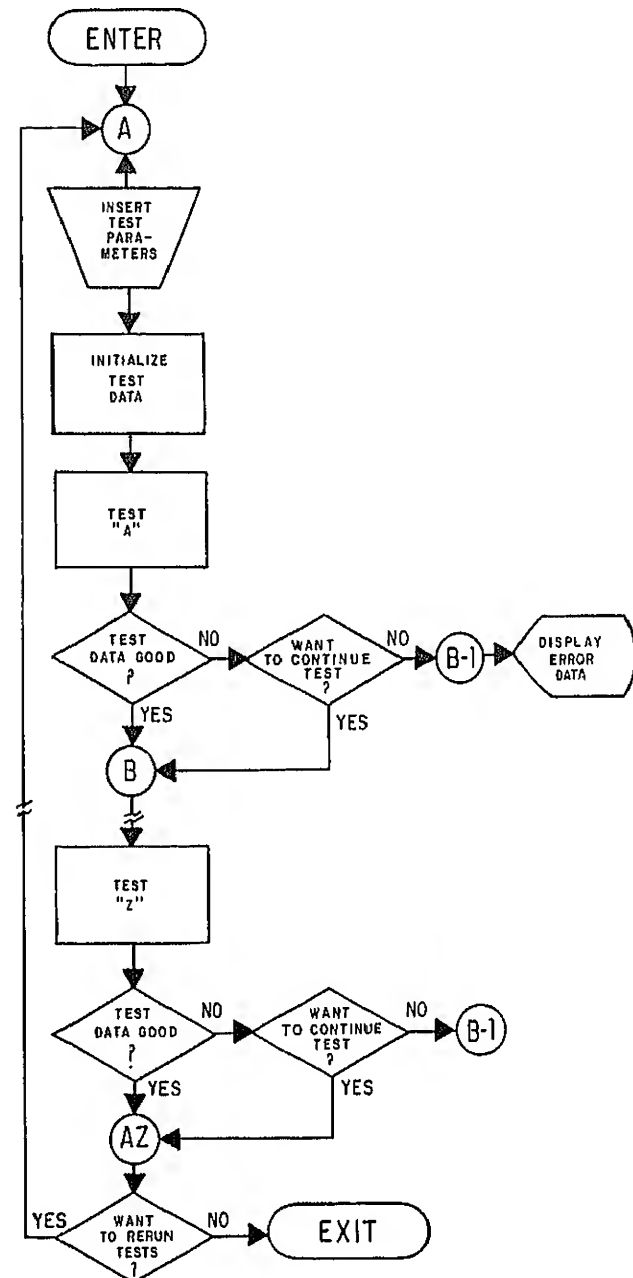After you have decided what tests you will perform, each one should be assigned a task statement. This could be a mnemonic statement such as, "INTERTEST" (Interrogation Test) or just plain TEST "A". Figure 3-4 is a sample diagnostic program flowchart. It starts out by allowing the test operator to initialize the test parameters. The first test, TEST "A", can be used to master clear the equipment under test and see if it responds to basic commands. TEST "B" through TEST "Z" would perform other desired tests. TEST "A" can be further flowcharted to show the steps involved in the test. Figure 3-5 is a sample flowchart of TEST "A". Here we see that TEST "A" is designed to check an unspecified piece of equipment and determine if it is ready for data transfer.

TEST "A" is entered, data is initialized (step 1), and an EXTERNAL FUNCTION (step 2) is

Figure 3-4.—Sample diagnostic program flowchart.
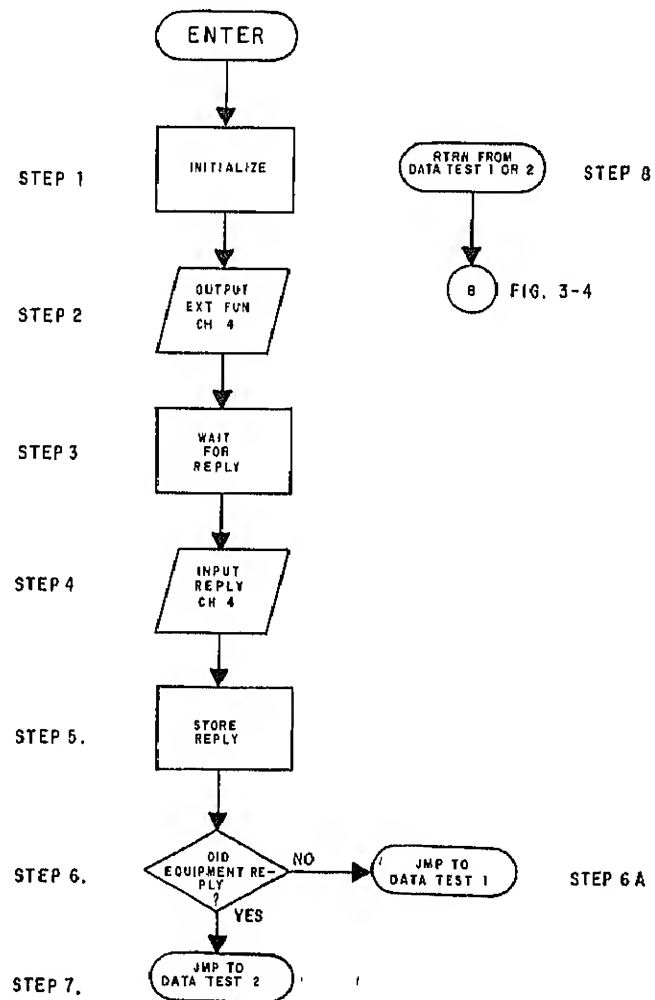
Figure 3-5.—TEST "A" flowchart.

sent to the equipment under test. The reply from the equipment under test will not come back immediately, so the program will have to wait (step 3). After a suitable time the program will initiate an input buffer (step 4) and store the reply (step 5). TEST "A" should check to make sure that the equipment did reply (step 6) and then exit to the data test subroutine (step 6A or 7). Step 8 is a switch which returns control back to the EXECUTIVE routine of the program if data is tested and found to be good.

After the flowchart for the test subroutine has been developed and checked to make sure no steps have been omitted, the program can be coded.

PROGRAM CODING.—Either a high-level or low-level language may be used for program coding. About 75 percent of the programming done today makes use of a high-level language such as BASIC, COBOL, or FORTRAN. The other 25 percent use a low-level language. Low-level languages are often termed machine code, machine language, or object codes. For the purpose of our programming, a hybrid language will be used to provide an example of a high-level language. This language has been developed by the author and is called general data translator (GDT). It is a hybrid combination of BASIC, CMS-2, and commands developed for the purpose of demonstration. Table 3-1 lists the GDT commands and their usage. These commands will be used in the remainder of this chapter to demonstrate the programs and subroutines developed from flow diagrams.

The program for TEST "A" can be written:

```
010   ENTER
015   LET A = "MASTER CLEAR"
020   OUTPUT A ON CH. 04
025   LET N = 1000
030   RPT NI N
035   WAIT
040   INPUT ON CH. 04 & STRE IN C
045   WHN C = 0 JMP TO 080
050   WHN C ≠ 0 JMP TO 090
055   RTRN TO
060   A "MASTER CLEAR"
065   B "READY TO RECEIVE" Interrupt
070   C (Interrupt Storage)
080   RTRN JMP TO 100
085   JMP TO 055
090   RTRN JMP TO 200
095   JMP TO 055
```

Basically, the program sends a MASTER CLEAR to the equipment under test, waits for a reply, stores the reply, and then checks the reply to see if data has been sent, and exits to either the subroutine DATA TEST 1 or DATA TEST 2.

TEST DATA

Test data can only be determined after you decide which circuits' functions you are going to test. It must be selected so that only suspected circuits are placed under test. Test data should produce a positive indication wherever possible. This means the test data should either cause some visual result (light a lamp) or produce a positive feedback signal to the computer used for the test. TEST "A", shown previously, clears the device and then waits for the READY TO RECEIVE interrupt from the device. Without a positive result from your test, you have no way of determining if an error or malfunction has occurred.

Checking Test Data

In figure 3-5, the flowchart indicates two subroutines for checking the results of TEST "A". Step 7, results when an interrupt has been received. DATA TEST 2 is the subroutine which will check to see if the data received is correct. Step 6A results when no data was received. Refer to figure 3-6 for simplified flowcharts of DATA TESTS 1 and 2.

DATA TEST 1.—DATA TEST 1 (figure 3-6A) determines if you want to continue on with the testing or display an error message. Step 1 is used to store an indication of an error. The error was determined in TEST "A". If you arrive at this test, no interrupt was sent from the peripheral device, and this indicates a communication failure between the computer and the peripheral device. Step 2 provides the decision to continue on with the test. Step 3 is an exit to the DISPLAY ERROR DATA subroutine. Step 4 would normally not be taken because the computer can't communicate with the peripheral.

DATA TEST 2.—DATA TEST 2 (figure 3-6B) determines if the data sent from the peripheral device is correct. Step 1 initializes the subroutine. Step 2 determines if the data word is

Table 3-1.—GDT high-level language

STATEMENT	MEANING
CLR ( )	Clear the contents of the specified address to all Øs.
HLT	Stop program at this point
INDX +	Increment index N by 1
INDX −	Decrement index N by 1
INPUT ON CH.c & STRE IN x	Input data from channel c and store the data in the addresses indicated by the address word x.
JMP TO ( ) IF	Jump to the address indicated if the condition is met. Ex. JMP TO 25Ø IF KEY 3 SET
LET	Assigns a value to a variable. Note 1. Ex. 1. LET A = ''CLEAR'' 2. LET Y = 1ØØØ 3. LET X = Y + Z
OUTPUT x ON CH.c	Output data contained in address x on channel c. Ex. 1. OUTPUT A ON CH.Ø4 2. OUTPUT ØØ1Ø ON CH.1Ø
RPT NI N	Repeat the next instruction (N) number of times. (N = any whole positive integer)
RTRN JMP TO	Jump to the address indicated and insert the address of the RTRN JMP TO instruction. Ex. RTRN JMP TO 25Ø (if the address of the RTRN JMP TO instruction was 1Ø5, the address in the ENTER address will be 1Ø5.)
RTRN TO	Jump back to the address + 1 in the ENTER address.
STRE ( ) IN	Store data in the address indicated Ex. 1. STRE y IN 25Ø 2. STRE 1ØØØ IN 3ØØ
WAIT	Do nothing
WHN JMP TO	When the value of a variable meets the conditions of the statement, jump to the address indicated. (See Note 2) Ex. 1. WHN y=Ø JMP TO 2ØØ 2. WHN y≠Ø JMP to 3ØØ

Note 1. Mathematical Operators + Add, − Subtract, × Multiply, ÷ Divide, √ Square Root	Note 2. Relational Operators = equal to ≠ not equal to < less than > greater than ≤ less than or equal to ≥ greater than or equal to
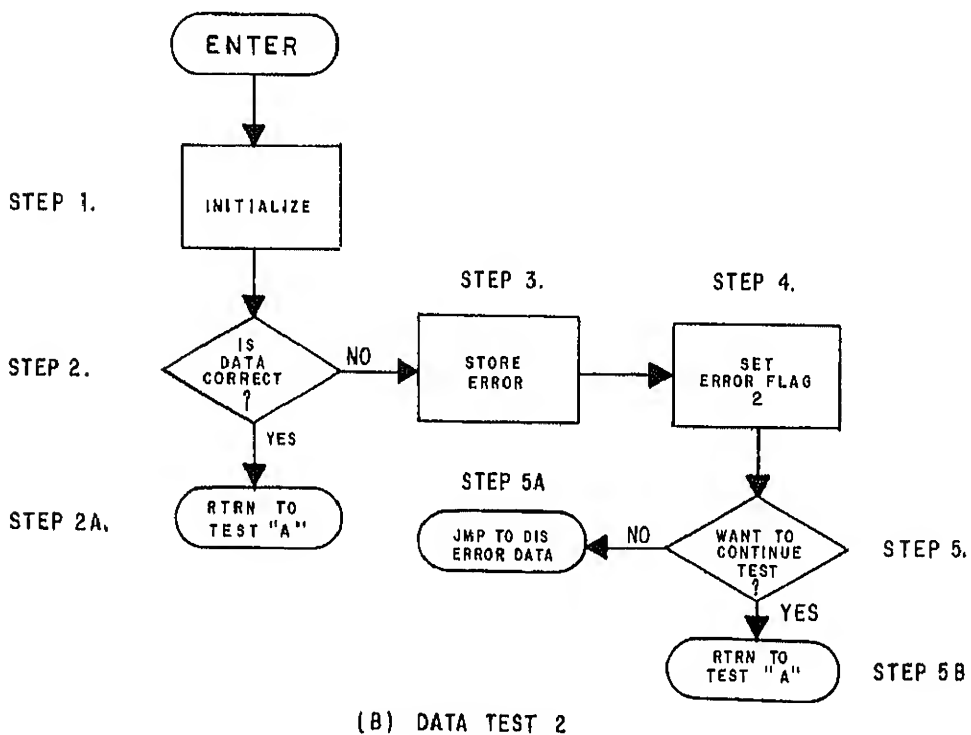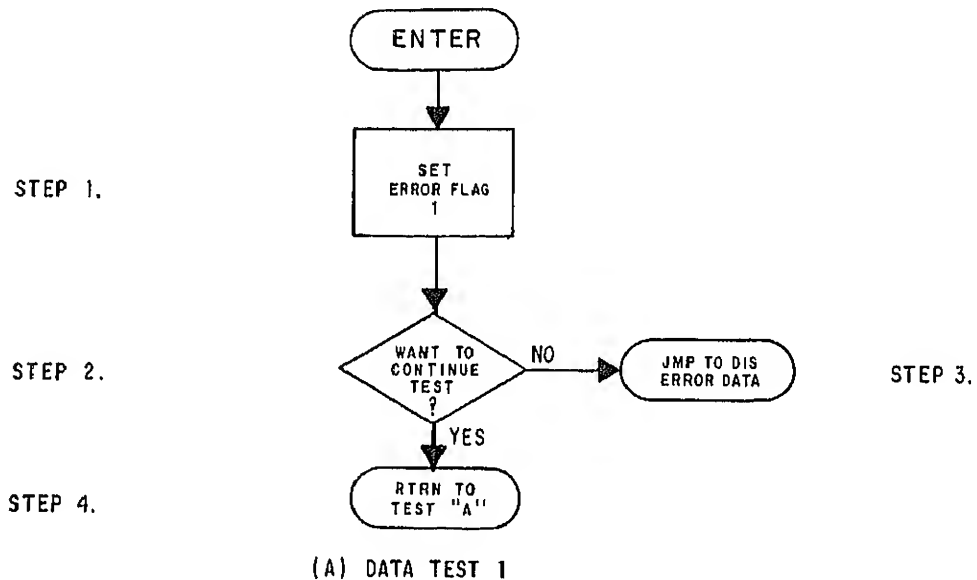
Figure 3-6.—Flowchart (a) DATA TEST 1, (b) DATA TEST 2.

correct. Step 3 stores the error data. Step 4 sets ERROR FLAG 2 to be used to indicate where the error came from. Step 5 determines if we want to go on with the test. Step 5B returns to TEST "A", while step 5A jumps to the DISPLAY ERROR DATA subroutine and terminates the testing.

DATA TEST 1 PROGRAM.—The DATA TEST 1 program is a relatively short subroutine:

```
100   ENTER
105   STRE "ERROR FLAG 1" IN 245
110   JMP TO 120 IF KEY 3 NOT SET
115   RTRN JMP TO 300 (DISPLAY ERROR DATA)
120   RTRN TO
```

Because an error was detected in TEST "A", this subroutine only sets an error flag, determines if the operator wants to continue with the test or terminate it. In this subroutine and the following ones, KEY 3 on the computer is used to indicate that an error printout is desired and the test is to be terminated. An additional instruction could be inserted before address 110 to keep TEST "A" repeating itself as an aid in troubleshooting the problem. The instruction below would keep on repeating TEST "A" as long as KEY 2 was set on our computer:

```
107   JMP TO 010 IF KEY 2 SET
```

Manual keys on computers are very helpful in modifying the running characteristics of a program. They allow the technician to use the test program in a loop to troubleshoot a function after an error indication has been detected.

DATA TEST 2 PROGRAM.—The DATA TEST 2 program is a slightly longer subroutine than DATA TEST 1:

```
200   ENTER
205   LET Y = B − C
210   WHN Y = 0 JMP TO 235
215   STRE Y IN 240
220   STRE "ERROR FLAG 2" in 250
225   JMP TO 235 IF KEY 3 NOT SET
230   RTRN JMP TO 300
235   RTRN TO
240   Y
245   ERROR FLAG 1 (EF1)
250   ERROR FLAG 2 (EF2)
```

This program checks to see if the data received in TEST "A" is correct. The data received was stored in address 070 as C during TEST "A". Now it is checked against the data, B, which should have been received. B is stored in address 065. WHN Y = 0 JMP TO 235 returns the program to TEST "A" because the data received was good. The data, Y, is stored for later use and the error flag is set. If KEY 3 is set, the program goes to the DISPLAY ERROR DATA subroutine so that the data may be displayed on a printer, crt, or by other means.

ERROR INDICATIONS

Error indications provide a method of determining whether a test has run successfully. TEST "A", which sends a MASTER CLEAR to a peripheral, could be checked by observing the status lights on the equipment. Many times the computer used for testing and the unit under test are physically separated by several compartments. Visual indications are only useful when the computer and equipment being tested are located close to each other. You, the DS, will have to decide how best to handle error indications in your program. Depending on the equipment available, you may use one of several types of input/output devices. The test can even be controlled from a console or a device you designate as the test control console. Key stops located on the computer or a remote operator console can be used to modify the operation of your program and produce various types of error readouts. Each portion of the diagnostic program should be kept as simple as possible. The error indications should be readily interpreted by your junior DSs.

Error Displays

In the previous program TEST "A", a test of a peripheral device was performed. The data was checked and errors were indicated if found by either DATA TEST 1 or DATA TEST 2. Now what is needed is a method of indicating the nature of the error determined by TEST "A". A printer or crt device would do for this. A display subroutine must be developed to produce an error

message. Since the subroutine can be used to display error messages from any data test, it must be able to determine what test has referenced the subroutine.

DISPLAY ERROR DATA FLOW-CHART.—The flowchart for the DISPLAY ERROR DATA subroutine is shown in figure 3-7. Error flags are checked and, if detected, a suitable message is displayed on the crt. The error flag table can be arranged in such a manner that it can be checked sequentially by a minimum number of instructions. In figure 3-7, only two error flags are checked. In reality, an indexing instruction would be used; and for every error flag set, a different error message would be generated. After the error message is displayed in this program, the error flags are cleared and the program stops. The subroutine could easily be designed to return to the main program and continue testing. This is only one example of the many different methods available for display of error results.
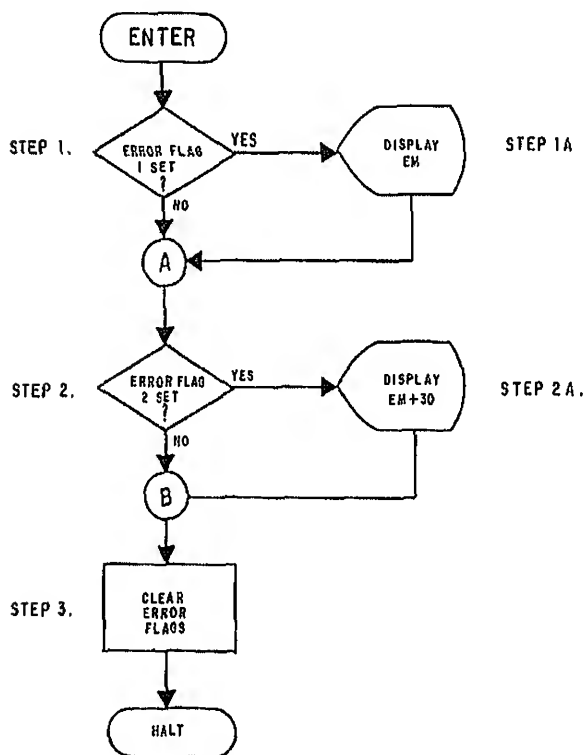
Figure 3-7.—DISPLAY ERROR DATA flowchart.

DISPLAY ERROR DATA SUBROUTINE.—The programming of the DISPLAY ERROR DATA subroutine can be handled in many different ways. Below is an example of a typical subroutine:

```
300   ENTER
305   WHN (245) ≠ 0 JMP TO 330
310   WHN (250) ≠ 0 JMP TO 340
315   CLEAR 245 (ERROR FLAG 1)
320   CLEAR 250 (ERROR FLAG 2)
325   JMP TO 360
330   OUTPUT EM ON CH. 05
335   JMP TO 310
340   LET V = INDEX
345   LET V = (300) - 200
350   OUTPUT EM + V ON CH.05
355   JMP TO 315
360   HLT
```

The Error Message Table used with this program is listed below:

```
400   EM          - "COMMUNICATIONS FAILURE ON CH. 04"
405   EM + 5   -
410   EM + 10 -
415   EM + 15 -
420   EM + 20 -
425   EM + 25 -
430   EM + 30 - "INTERRUPT WAS" C "SHOULD BE" B
435   EM + 35 -
```

Instructions 305 and 310 determine if the error flags are set. Instruction 330 outputs error message 1, EM, to the display informing the program operator there is a communication failure on Channel 4. Instructions starting at 340 check the entrance address to see which DATA TEST subroutine referenced this subroutine. V is the index variable which is determined by instruction 345 and then used to locate the correct error message. Instruction 350 produces the error message, EM + V, which informs the operator that the "INTERRUPT WAS" C, "SHOULD BE" B. The program jumps back to 315, clears the error flags and then halts. This subroutine is a very simple example of how to produce an error message. The addresses of the error flags could be used to determine the message index. The limit is the imagination of each individual programmer.

SPECIAL TEST PROGRAMS

A special test program could be defined as a special purpose program. It could be used to

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produce a display to check out the character generator of a crt console or the memory of a computer. Some special test programs are merely glorified test subroutines. They usually are developed to fill a gap found in the testing capability of available programs. Many special test programs are developed by field engineers to test out the operability of new equipment. In many cases, modifications are made to systems before software can be developed to test the modifications. The field engineer or senior DS at the site or aboard the ship must develop a method of testing. The same criteria used to determine the needs for a diagnostic program may be used for special test programs. Refer to the flowchart in figure 3-2.

SUMMARY

This chapter has discussed programming in terms of maintenance and troubleshooting. No attempt has been made to discuss a specific system or a specific language. All personnel in the DS rating will, at some time, be required to write a short program or analyze an operational program at their site. It is hoped that this chapter has given a small insight to the considerations required to develop and use various maintenance oriented programs.

Additional information on the basic concepts of programming may be found in *Digital Computer Basics*, NAVEDTRA 10088 (Series).

GLOSSARY OF ABBREVIATIONS

ABBREVIATION	DEFINITION
ASW	Antisubmarine Warfare
BASIC	Beginners All-purpose Symbolic Instruction Code
CMS-2	Compiler Monitor System—2
COBOL	Common Business Oriented Language
crt	Cathode-ray Tube
EDP	Electronic Data Processing
FORTRAN	Formula Translator
GDT	General Data Translator
GPAC	General Purpose Action Code
I/O	Input/Output
NTDS	Naval Tactical Data System
OP	Operational Program
PEFT	Programmed Equipment Functional Test
POFA	Programmed Operational and Functional Appraisal
SDC	Signal Data Converter
SOM	System Operation Manual
STR	Software Trouble Report

F

IS A SPECIAL TEST PROGRAM AVAILABLE TO TEST THIS EQUIPMENT ? — NO → G

YES

LOAD AND RUN SPECIAL TEST PROGRAM

DOES A PROBLEM INDICATION SHOW-UP ? — NO → G

YES

CAN THE PROBLEM BE LOCATED USING THIS PROGRAM ? — NO → G

YES

D

G

CAREFULLY ANALYZE SUSPECTED PROBLEM

DECISION "A" (NOTE 1) — NO → H

YES

DEVELOP AND RUN A SPECIAL TEST OR DIAGNOSTIC PROG FOR THE SUS-PECTED PROBLEM

CALL FOR TECHNICAL ASSISTANCE

EXIT

H ← NO — DOES THE PROGRAM PRODUCE A PROBLEM INDICATED ?

YES

CAN THE PROBLEM BE LOCATED USING THIS PROGRAM ? — NO → H

YES

D

151.347

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